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ABSTRACT

This document is intended as a guide for both experienced and inexperienced teachers of Regents Biology in New York State. It presents a collection of demonstrations, activities, and strategies designed to enrich the teaching of that course. The guide includes seven units of study. Units are focused on unity and diversity among living things, maintenance in living things, human physiology, reproduction and development, genetics, evolution, and ecology. The format for each unit includes: (1) a unit theme, which provides an overall summary describing the rationale for the unit; (2) a topic theme, which highlights the key points to be found in each topic included in the unit; (3) teaching strategies, a personalized introspective device detailing suggested approaches for treating the subject matter; (4) instructional objectives, which are keyed to syllabus content and placed in sequential order; and (5) teaching activities, which include demonstrations, laboratory experiments, student projects, reports, and guest speakers. Also included are sections on laboratory skills and career information. (TW)

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A Teacher's Resource Guide

to

REGENTS BIOLOGY

SE 048 317

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EXPERIMENTAL, 1984
2

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Foreword

A Teacher's Resource Guide to Regents Biology is intended as a guide both for experienced and inexperienced teachers. It presents a collection of demonstrations, activities, and strategies designed to enrich the skeletal outline presented in the regular and extended parts of the New York State Syllabus. Both documents used together will provide a valuable resource for teachers.

For each unit, we have provided the following format:

1. Unit theme - overall summary describing the rationale for the unit.
2. Topic theme - highlights of the key points to be found in each topic included in the unit.
3. Teaching strategies - a personalized instrospective device detailing suggested approaches in treating the subject.
4. Instructional objectives - keyed to syllabus content and placed in sequential order. These can easily be rephrased as "aims."
5. Activities - probably the most useful section of the manual. The activities are keyed as follows:

D = Demonstration
L = Laboratory
P = Student Project
R = Report
S = Guest Speaker

Many activities will be keyed in more than one category, thus a teacher demonstration may be converted to a class laboratory lesson and/or student project.

Finally, an attempt was made to select activities that were inexpensive, relatively easy to set up, and designed to clearly demonstrate specific concepts. The goal of these activities is learning by inquiry and the maximization of student participation.

No guide is intended to be all-inclusive. At the same time no teacher should be expected to do all of the activities listed in a section. The unique needs of your school will govern the extent to which this guide should be utilized.

Your reactions and comments to these materials will be appreciated. A form is appended on the last page of this book for your convenience.

Charlotte Frank

Charlotte Frank
Executive Director
Division of Curriculum & Instruction

Acknowledgments

This curriculum bulletin, A Teacher's Resource Guide to Regents Biology, is a project of the Division of Curriculum Development and Support, Morris Freedman, Director, under the auspices of the Division of Curriculum and Instruction, Charlotte Frank, Executive Director.

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Table of Contents

Unit I: Unity and Diversity Among Living Things **1**
Topic 1: A Concept of Life 2
Topic 2: A Scheme of Classification 6
Topic 3: Unity of Life 10
Model Lesson Plan 20
Unit II: Maintenance in Living Things **22**
Topic 1: Nutrition 23
Topic 2: Transport 33
Topic 3: Respiration 40
Topic 4: Excretion 46
Topic 5: Regulation 50
Topic 6: Locomotion 58
Model Lesson Plan: Nutrition 62
Unit III: Human Physiology **64**
Topic 1: Basic Anatomy and Physics of Human Digestion System 65
Topic 2: Transport 78
Topic 3: Respiration 87
Topic 4: Excretion 93
Topic 5: Regulation 101
Topic 6: Locomotion 110
Model Lesson Plan 115
Unit IV: Reproduction and Development **118**
Topic 1: Asexual Reproduction 119
Topic 2: Sexual Reproduction 129
Model Lesson Plan 141
Unit V: Genetics **143**
Topic 1: Foundation of Genetics 144
Topic 2: Some Major Genetic Concepts 148
Topic 3: Mutations 152
Topic 4: Genetic Application to Animal and Plant Breeding 156
Topic 5: Interaction of Heredity and Environment 159
Topic 6: Human Heredity 162

Topic 7: Modern Genetics 165
Model Lesson Plan: Foundation of Genetics 171
Model Lesson Plan: Some Major Genetic Concepts 173
Model Lesson Plan: Mutations 175
Model Lesson Plan: Genetic Applications to Animal and Plant Breeding 177
Model Lesson Plan: Interaction of Heredity and Environment 178
Model Lesson Plan: Human Heredity 180
Model Lesson Plan: Modern Genetics — Lesson One 181
Model Lesson Plan: Modern Genetics — Lesson Two 182

Unit VI: Evolution 184
Topics 1 & 2: Evolution and Evolutional Theory 184
Topic 3: Heterotroph Hypothesis 192
Model Lesson Plan 196

Unit VII: Ecology 198
Topics 1 & 2: Ecology and Ecological Organization 199
Topic 3: Ecosystems 205
Topic 4: Biosphere and Humans and the Future 212
Model Lesson Plan 216

Laboratory Skills Section 219

Career Information by Unit 281

Career Information Resources 295

x

NOTE TO TEACHERS

Regulation 8.2(C) of the Rules and Regulations of the New York State Commissioner of Education states:

> "Only those persons who have satisfactorily met the laboratory requirement as stated in the State Syllabus for a science shall be admitted to a Regents examination in such science."

This stipulation pertains to all students taking Regents science courses in New York City. Since all Regents science courses are laboratory courses, all students are required to complete 30 laboratory experiences (or periods) in order to be eligible to sit for the Regents examination.

Anthony Galitsis,
Director of Science,
Division of Curriculum and Instruction
New York City Board of Education

Unit I: Unity and Diversity Among Living Things

pages 1 to 17

Suggested time: 14 to 21 days

Unit Theme: A living organism performs its life functions within a dynamic but delicate internal and external environment. These life functions are performed by interacting with the abiotic and biotic factors of the environment, with adaptations made by individual organisms.

Topic 1: *A Concept of Life*

Pages 2 to 3

Suggested time: 2 to 3 days

Topic Theme: Living organisms perform all the activities essential to sustain life. Nonliving organisms may perform one or more but not all of these functions. Organisms possess specific structures that enable them to perform their life functions.

Teaching Strategies: *An Overview*

In approaching this unit and indeed most units in biology, the teacher should utilize the concept of structure and function relating both to the performance of the life functions in representative organisms. Emphasis on the comparative anatomy of organisms should result in the appreciation of the unity that is implicit in the performance of life activities of all organisms. The identification of biochemical compounds, metabolic reactions, and scientific techniques are required for the understanding of the manner in which life activities are performed.

Teaching Strategies: *Sequential*

1. Display examples of living, nonliving and preserved specimens. Ask students to categorize each item as living or nonliving and provide a definition for the term life.

2. Ask students to give a working definition in their own words of each life function. Students should relate each life function to the chemical and physical activities of living organisms.

3. Discuss nutritive requirements in terms of the metabolic needs of cells. Ask students to relate the totality of metabolic activity to the individual life functions of cells and organisms.

4. Demonstrate the dynamic ebb and flow of substances used by living things (e.g., water, oxygen, carbon dioxide). Use a balanced aquarium to elicit the dynamic chemical balance maintained by living things. Ask students to define the term homeostasis and relate this concept to each life function.

Performance Objectives

Students will be able to:

- define life in terms of the activities performed by living things.
- list the characteristics of each life function.
- relate the definition of each life function to the actual performance of each function by living things.
- relate the life functions to the total sum of biochemical activities of an organism (metabolism).
- discuss the integrated manner in which organisms use their structures to maintain a stable natural environment (homeostasis).
- interpret life activities as a series of dynamic changes needed to sustain life.

Activities

1. [D,L] Life functions of microorganisms -- Use a microprojector to show hydra, algae, and protozoa. Ask students to explain how they know that these organisms are alive. Ask how the activities they observe conform to the definition of life.

2. [D,L] Life functions of earthworm; overhead projector -- Utilize an overhead protector and a Petri dish to display a live earthworm. Demonstrate how a multicellular organism (a glass shrimp obtained from salt water marshes can also be used) can respond to a variety of stimuli, e.g., light, weak acid, temperature variations.

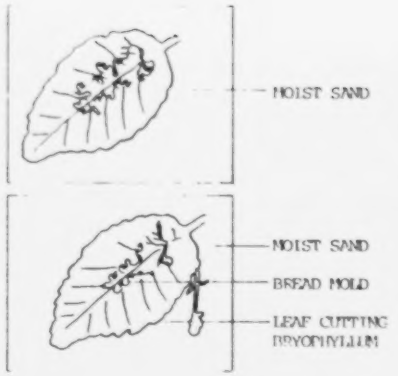
3. [D,L] Fish bowl (balanced aquarium) -- Bring to class a balanced aquarium. Keep the bowl out of sight at the beginning of the lesson. At the proper moment, put the bowl on the demonstration table. Check for visibility. Ask students to design categories of all the items in the display and give reasons for their choices. (Make sure that there are plants, fish, rocks and other objects in the bowl.)

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

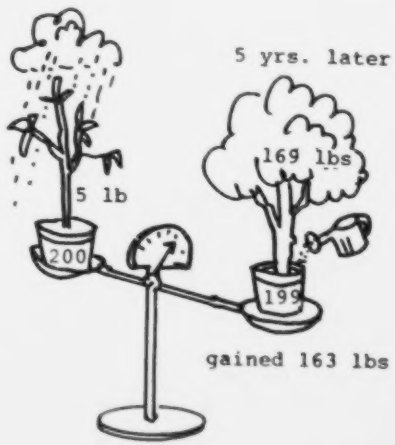
4. [D,L] Classifying living/nonliving specimens -- Display samples of plants, bacteria in culture dishes, numerous rocks and fossils, a goldfish or frog. Ask students to classify each object as living or nonliving and to justify their choices.

5. [D,L] Seed and brine shrimp observations -- Show the class a package of seeds and ask the question: "Are these seeds alive?" (Brine shrimp eggs can also be used.) Suggest that some students design an experiment to demonstrate if these seeds are alive.



6. [D,L] Respiration demo -- Ask students to compare the burning of a candle to a living organism (a pet). Display both.

7. [D,L] Bread mold experiment -- Place a leaf of bryophyllum in two different flower pots of sand; add bread mold scrapings to one leaf. Place both pots in the sun. Invite students to (a) observe, (b) make predictions of the outcomes in each case, and (c) describe the results after a few days. Ask them to explain their observations based on their understanding of the performance of life functions.



8. [D,L] Metabolism: van Helmont's experiment -- Distribute a sheet displaying a graphical and pictorial representation of van Helmont's experiment. Explain the results.

Ask students to discuss changes in the tree and soil as they relate to the performance of life functions and to the relationship of living and nonliving aspects of the environment.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 2: *A Scheme of Classification*

Pages 3 to 6

Suggested time: 3 to 5 days

Topic Theme: There is both unity and diversity in nature. All living things perform basically the same life functions but in different ways using different structures and in many diverse environments.

Teaching Strategies: *An Overview*

The instructor will ask students to explain the need for scientific classification of organisms. The use of various classification schemes will demonstrate the nature of scientific inquiry. The use of these schemes by students observing and classifying organisms allows them to evaluate the purpose and the process of classification.

Teaching Strategies: *Sequential*

1. Display numerous specimens of plants, animals, and Protista. Have students develop a simple method for categorizing each organism. Ask them to provide a rationale for the system of classification they propose.

2. Distribute a chart listing the five kingdom classification systems. Ask students to list the criteria used for placing organisms in each kingdom, i.e., (a) presence or absence of a nuclear membrane, (b) unicellularity or multicellularity, or (c) type of nutrition.

3. List several examples of common organisms, i.e., cat, dog, lion, horse, or plant. Ask students to place these organisms into their respective kingdom, and phylum. Discuss the use of binomial classification for categorizing these organisms.

Performance Objectives

Students will be able to:

- indicate the value of a classification system.
- construct their own system of classification.
- explain, given several organisms,the purpose and methods for placement of living things into a classification scheme.
- use the modern classification system to classify commonly known organisms.
- distinguish among the terms kingdom, phylum, genus, and species.
- classify common organisms (including humans) using these classification terms.

Activities

1. [D] Student classification -- Display living and/or preserved specimens of plants or fungi and members of the five classes of vertebrates. Ask students to organize these living organisms into a logical category.

2. [D,L] Recording differences within "families" -- Show pictures of cats, lions, leopards and other members of the same family. Ask students to distinguish among them and justify their answers.

3. [D] Classification of microorganisms -- Ask students to view organisms on a microprojector screen and to develop a classification key that segregates the organisms being observed (suggested organisms: bacteria in yogurt, amoeba, euglena, or stentor. Ask students to list similarities and differences in these organisms.

4. [D L] Classifications in the news -- Ask students to read an article tracing the discovery of a new form of life, the methanogens. Ask them to discuss the problems created in classifying this organism and the adaptability of classification schemes to incorporate the placement of newly found types of living things.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

5. [D,L] Make your own classification system -- Ask students to make a study of a stamp collection, a TV guide, or an automobile catalogue and devise a classification scheme for one of them. Have them list the criteria used for creating their system.

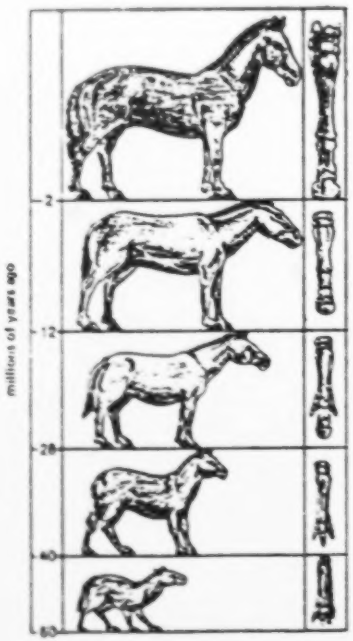
6. [D] Library classification system -- Ask students to compare the method in which books are categorized in the library with the contemporary biological classification system.

7. [D] Binomial nomenclature -- Display pictures of different dogs, cats, or maple trees. Ask a student to pick up the picture of the dog and display it to the class. Whatever picture is selected, advise him that it is the wrong picture, and that he should select a different one. The class will soon understand the need for a binomial nomenclature that utilizes a first and last name.

Platypus

8. [D] Odd animals -- The duckbilled platypus should permit students to realize that some organisms are difficult to classify.

9. [D,L] Evolution of eohippus -- Ask students to trace the development of the modern species of horse. Encourage the use of models.



10. [D] Preserved specimen display -- Most schools maintain a museum of preserved animal and plant specimens. Display as many as you reasonably can. Be sure to include both plants and animals. Without elaborating on the specimens themselves ask for a volunteer to display THE ANIMAL to his peers. The confusion obviously will result when the student cannot comply with your request and must ask you to be more specific as to the type of animal you wish to observe. The need for a classification scheme is now established.

11. [D, L] Field trip for classification -- Conduct a field trip around your school carefully using prepared markers at specific stations. Use a field study guide to prepare a key for common organisms. Have the students report the special structural adaptations of these organisms. Ask them to list possible evolutionary trends in these organisms (types of nutrition or body plan).

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 3: *Unity of Life*

Pages 6-17

(suggested time: 9-13 days)

Topic Theme: Cells are the basic structural and functional units of life. Some organisms and cells are exceptions to the cell theory of life. Recent discoveries in support of this theory have resulted from experimentation with new microscopes and sophisticated technology.

Cells perform metabolic activities through the coordinated effort of cell organelles. These activities depend on a dynamic balance of specific chemicals which regulate activities in metabolic pathways.

Teaching Strategies: *An Overview*

An understanding of the structure and function of the cell is basic in learning the life activities of multicellular organisms. Throughout the course students will be expected to explain how life activities are performed by representative organisms. Therefore the essential framework for the course revolves around this topic.

Teaching Strategies: *Sequential*

1. Display pictures, models, and/or examples of early microscopes. Ask students to discuss the work of early scientists that led to the establishment of the cell theory.

2. Display pictures of various instruments including microscopes, ultra-centrifuges, chromatography apparatus. Ask students to relate the use of these modern tools and techniques to the development of our current understanding of the cell.

3. Ask students to identify cell organelles in terms of the life functions carried out by the cell.

4. Discuss methanogens, viruses, and other exceptions to the cell theory. Elicit the value of these exceptions to dynamic scientific inquiry.

5. Discuss the role of inorganic and organic compounds found in cells. Ask students to discuss the similarities and differences in structure and function. Discuss the role of ionic and covalent bonding in relation to their effects on the chemical properties of these compounds.

6. (Extended) Use molecular model kits to allow students to learn the basic structure of inorganic and organic compounds essential to life.

7. Discuss the role of variable structures of proteins in the process of becoming amino acids in the production of enzymes. Ask students to relate the specificity of enzymes to their protein structure.

8. (Extended) Describe how enzyme activity is affected by pH, temperature, and substance concentration. Ask students to interpret graphical representations of these relationships.

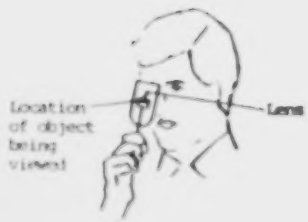
Performance Objectives

Students will be able to:

- describe how instruments used by scientists have increased our knowledge of the cell.
- describe the advantages and disadvantages of different types of microscopes.
- identify the structure of basic elements used by living things in the synthesis of more complex molecules.
- explain chemical reactions in terms of electrons and their interactions.
- give examples of chemical reactions involving organic and inorganic compounds used by living things.
- identify the major organic compounds found in living things.
- (extended) describe the synthesis and hydrolysis of fats, proteins, and carbohydrates.
- describe the role of enzymes in living organisms.
- explain the lock-and-key concept of enzyme action.
- (extended) graph the effect of temperature, pH, substrate, and enzyme concentration on enzyme activity.

Activities

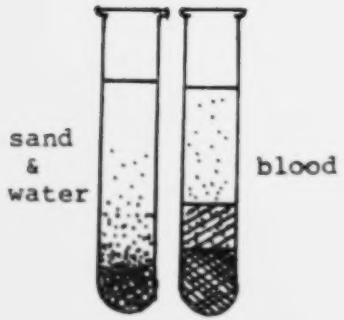
1. [D,L] Early microscope -- Construct a model of the first simple microscope made by Leeuwenhoek (or show an enlarged picture). Ask students to explain how this device may have been used. Ask them to identify the parts of this instrument. Ask students to compare Leeuwenhoek's microscope with modern microscopes. Show students a magnifying lens and ask them to compare with a modern microscope.



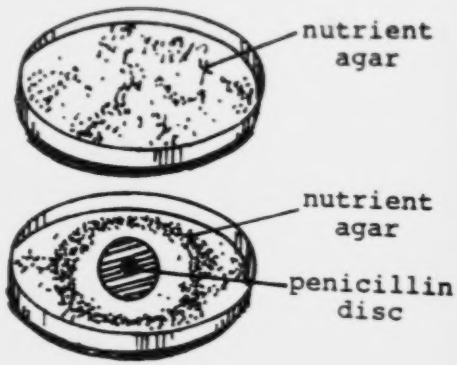
2. [D,L] Early and modern microscopes -- Show two pictures of New York City--one view from an airplane, the other from street level. Ask students to relate the differences observed to the different detail of cell structure using early and modern microscopes.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

3. [D,L] Use of centrifuge -- The use of a centrifuge may be demonstrated by placing a sample of blood or water with sand. Ask students to determine the value of this instrument for cell study. Compare with ultracentrifuge.



4. [D,L] Growth of organisms -- Show the class two exposed Petri dishes containing nutrient agar and bacteria, one of which contains a penicillin disc. Ask them to explain the growth patterns with special attention to the zones of inhibition.

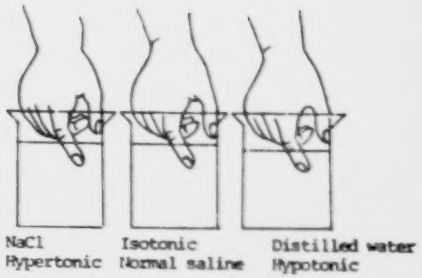


5. [D,L] Fantastic voyage to the cell -- Ask students to imagine they are scuba divers preparing to enter a cell. Their room is a gigantic cell. Each juncture of the trip will be related to an examination of cell parts, their structure and function. Utilize a worksheet for descriptions and drawings of cell parts. If available, provide students with electron micrographs of various cell organelles, e.g., chloroplasts, mitochondria, etc. The visuals should enhance their descriptions.

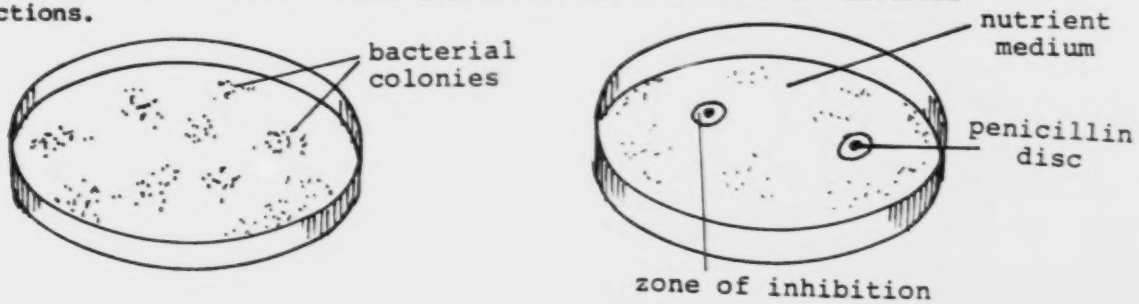
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

6. [D,L] Role of cell membrane -- Perform the following experiment: Place fingers in three different beakers containing samples of sodium chloride (hypertonic), saline (isotonic), and distilled water (hypotonic). Have students determine the results of this experiment in relation to the cell membrane and cytoplasm found in skin cells.



7. [D,L] Penicillin and bacterial cells -- Ask students to research the effect of pencillin on the growth of bacterial cells. Specific details of cell wall structure can be derived as a result of this research. Ask students to explain why penicillin is ineffective in treating viral infections, and why it is the "drug of choice" among physicians for treatment of bacterial infections.



8. [D,L] Role of nucleus -- Prepare transparencies or worksheets describing the role of the nucleus in (1) the acetabularia experiment, (2) the cloning experiments of J. B. Gurdon, and (3) the recombinant DNA research on insulin and interferon production by bacteria. Ask students to discuss the role of the nucleus in each of these experiments.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

9. [D] Jules Verne's Voyage to the Moon -- Read a section of Jules Verne's Voyage to the Moon. How does Verne's description compare with modern-day space exploration? Explain why space flight is possible today but was not possible in the early 1900's. Relate present-day knowledge of cell structure to that known at the time of Leeuwenhoek.

10. [D, L] Simple microscope -- Distribute a newspaper (select pages with pictures) to the class. Provide each students with a magnifying glass. Ask them to compare what is observed with the magnifying glass as opposed to what is observed with the unaided eye.

11. [D,L] Animal cell, plant cell slide -- Compare a stained and unstained slide of cheek cells or onion cells. What are the advantages and disadvantages of staining techniques?

12. [D,L] Metric measurement -- Provide each student with a metric ruler. Allow your students to visualize the difficulty in measuring cells with the ruler, and establishing small units (micrometers). Refer to Section 1, General Science Course of Study-Curriculum and Instruction Publication, Board of Education, 198_ for additional demonstrations and activities utilizing metric measurement.

Caustic Substance

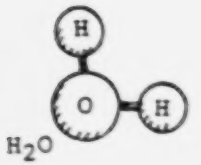
Dangerous Vapors

13. [D,L] Inorganic compounds in living systems -- Display samples of iron filings, sulfur powder, powdered carbon, solid sodium, and chlorine gas. Establish relationships between inorganic elements and living systems by displaying alongside the inorganic substances blood, chlorophyll, and nerve cell model - e.g., the presence of carbon in each of the inorganic substances.

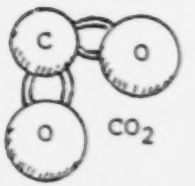
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

14. [D,L] Molecular model kits -- Use molecular model kits to have students familiarize themselves with the structural formulas of H_2O, CO_2, O_2 H_2O_2, HCl and NaCl.



15. [D,L] Chemical and physical changes -- Mix sulfur and iron; separate with magnets. Heat and ask students to determine the nature of a chemical change.



16. [D,L] Organic versus inorganic compounds -- Display a variety of chemicals in containers that clearly identify the contents with labels that give empirical formulas and chemical name. Ask students to classify the chemicals as organic or inorganic.

17. [D,L] Oxidation versus respiration -- Demonstrate how 2 activities can produce the same result: placing a glowing wooden splint in limewater and exhaling into limewater (both produce cloudy lime water). Students should be asked to explain the relationship.

18. [D,L] Destructive distillation: organic versus inorganic -- Burn paper, wood splints, sugar and/or starch to demonstrate commonality of substances remaining: a black residue (carbon) and water vapor. Compare process of burning with cellular oxidation.

Key: D - demonstration, L - laboratory lesson, R - report, S - speaker, P - project

Activities (continued)

19. [D] Butter Candle -- Burn a butter candle or a cashew nut. Why do fat or oil products burn so efficiently?

20. [D,L] Calorimeter -- Use a calorimeter to measure heat changes by burning fats (nuts), protein (beef), and carbohydrates (sugar cube). Elicit the function of food for metabolic activity and production of energy.

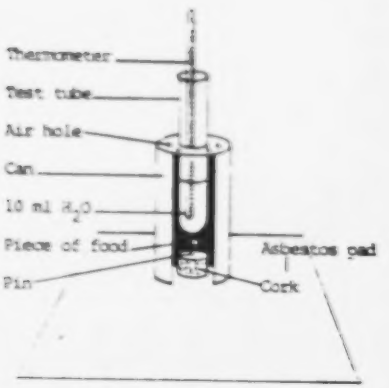
21. [D] Molecular structure of organic compounds -- Use molecular model kits to demonstrate the structure of a mono and a disaccharide, a dipeptide, and glycerol. Illustrate the process of dehydration synthesis and hydrolysis.

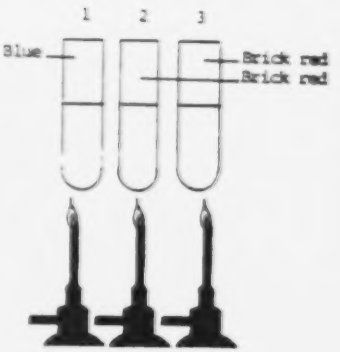
22. [D] Hydrolysis -- Demonstrate hydrolysis of starch by passing out crackers and asking students to chew for two to three minutes and describe what has taken place. Explain why the substance has become sweeter in taste.

23. [D] Food labeling -- Ask students to bring in labels from food jars and packages. Discuss the types of chemical compounds found in food. Discuss the role of otner additives and preservatives and their possible effects on cell metabolism. Define common terms like roughage, fiber, natural, and organic.

24. [D, L] Food tests -- Conduct food tests for the following nutrients: biuret - protein; indolphenol - vitamin C; paper tests - fats and oils; benedict's solution - sugar (not sucrose).

25. [D] Samples of proteins -- Display samples of proteins such as hair, feathers, wood, and silk. Read the label of common products which contain proteins, i.e., shampoos, conditioners, and skin treatments.





Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

26. [D] Empirical versus structural formulas -- Use transparencies to illustrate empirical formulas, structural formulas, chemical reactions, and building blocks.

27. [D] Geometric and empirical cutouts -- Paper cutouts of formulas can be pasted on magnetic strips and moved about on a chalkboard. Most chalkboards have a metal support and will permit adherence.

Safety Glasses

28. [D, L] Diastase/saliva reaction in test tube -- Add commercially prepared diastase to one test tube containing starch. Add saliva to another test tube containing starch. Test for sugar (mix vigorously); compare and explain.

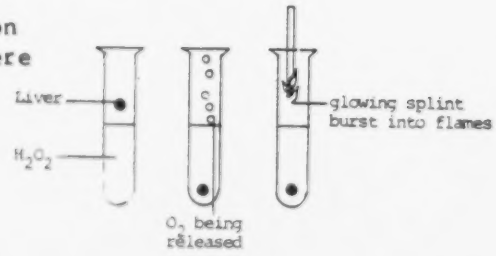
Fire

29. [D, L] Acidbase chemical indicators -- Demonstrate the affects of acid and base solutions with a variety of indicators. Changing colors provides visual enjoyment while allowing for an excellent motivation.

30. [D, L] Food test: ripened/unripened bananas -- Test a green banana and a yellowish brown banana for starch and sugar. Compare and explain.

Fire

31. [D, L] Enzyme activity -- Place a piece of liver into a test tube containing hydrogen peroxide. Ask students to identify the type of reaction involved. Ask students to hypothesize what would happen if cooked liver were used.



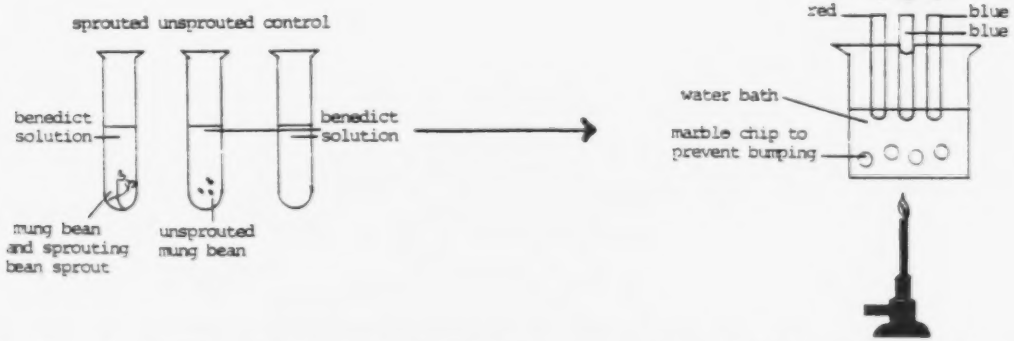
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Safety Glasses

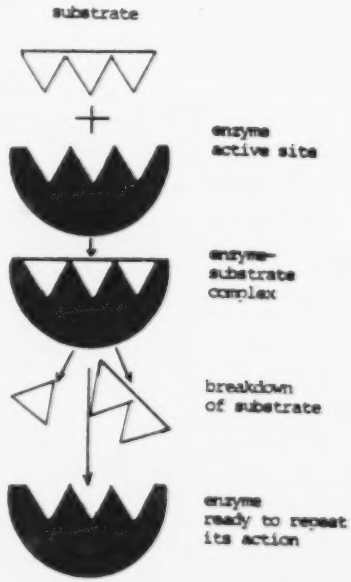
Fire

Activities (continued)

32. [D, L] Digestion-hydrolysis of starch -- Place Benedict's solution into three test tubes. Add to one sprouted beans and to the second unsprouted seeds. Heat all three in a water bath (beaker with boiling chips). Explain the results. [Illus. 17]



33. [D, L] Enzyme action--lock-and-key concept -- Utilize geometric models of the enzyme and substrate to demonstrate the lock and key concept. Relate activity to the active site of enzymes. [Illus. 18]



34. [D, L] Protein structure -- Place paper model cutouts representing amino acids along a string. Move the paper building blocks along the string to demonstrate the variability of protein structure.

35. [D, L] Making yogurt or wine -- Encourage students to make yogurt. A presentation of this process will provide a practical application of the process of fermentation. An alternate suggestion may be a description of the process of making wine or beer.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Model Lesson Plan

Aim: How can we distinguish between things that are living and not living?

Performance Objectives: Students will be able to

. distinguish between living and nonliving specimens.
. define life in terms of the life functions performed by living things.
. relate how the life functions are related to homeostasis.

Motivation: Bring to class a balanced aquarium or a terrarium. Keep the aquarium out of sight at the beginning of the lesson. At the proper moment, place the aquarium on the demonstration table. Check for visibility. Ask students to categorize all of the items in the display as either living or not living and give reasons for their choices. (Make sure that there are plants, fish, rocks, and other diverse items in the container.)

Concept Questions

1. What activities are characteristic of living things?

2. How do living things interact with the environment?

3. How do different living organisms perform their life functions?

4. Why is reproduction not essential for an individual's survival? Explain.

Concepts: Living things must be able to perform essential activities. Different organisms perform these functions in varying ways through the use of special adaptations and body structures.

Demonstrations

1. Using a microprojector, have the class observe specimens such as hydras, paramecia, algae, amoebas and others. Ask students to list the life activities performed by these organisms and to determine the specific structures that each organism uses to perform these functions.

2. Utilize an overhead projector and a Petri dish to display a live earthworm. Demonstrate how this multicellular organism can respond to stimuli, move, and perform other life activities.

3. Show the class a package of seeds and ask the questions: "Are these seeds alive?" (Brine shrimp eggs can also be used.) "How can you determine if these seeds are alive?"

Applications

1. What criteria would you use to determine if a newly discovered specimen is a living organism?

2. How does a virus represent an exception to the criteria established in this lesson?

3. What life activities are carried out by a burning candle?

Unit II: Maintenance in Living Things

Pages 20 to 44

Suggested time: 27 to 44 days

Unit Theme: Living organisms perform all the activities needed to sustain life. These activities allow organisms to obtain, synthesize, process, and distribute nutrients while producing energy, new compounds, and wastes. The regulation of metabolism includes maintaining a homeostatic balance of energy, useful nutrients, and metabolic waste.

Each organism has adapted to its environment by utilizing special structures. Thus plants and animals perform the essential life functions in varying ways. The adaptations used in performing life functions foster interrelationships between living things and their environment.

Topic 1: *Nutrition*

Pages 20 to 29

Suggested time: 5 to 8 days

Topic Theme: Nutrition is the life function whereby nutrients are obtained and processed for use as energy and materials for growth, repair, and regulation.

Teaching Strategies: *An Overview*

The teacher should build upon the basic concepts of structure and function, homeostasis and evolution as they apply to the life functions performed by the representative organisms. The inclusion of plants in this unit adds to the representation of life forms.

Teaching Strategies: *Sequential*

1. Introduce this topic by motivating students to appreciate the importance of the basic food groups. Current research describes the importance of vitamins, proteins, and fiber as important products made and processed by organisms.

2. The conversion of light (radiant) energy into chemical bond energy is a major concept in autotrophic nutrition involving green plants. Chemosynthesis is another form of autotrophic nutrition in which energy is obtained from chemical compounds without the use of light energy.

3. (Extended) The photolysis and carbon fixation reactions can be taught by utilizing various demonstrations showing the function of chlorophyll, chloroplasts, carbon dioxide and water. The structure of the leaf is perfectly adapted to perform photosynthesis. The logical approach of teaching the relationship of structure to function works well using cross sections of the leaf made in class and projected on the board using the microprojector. Diagrams (in color) drawn on the board and accompanied by duplicated sheets are helpful additions.

4. The structure of the leaf may also be used to trace the utilization of the raw materials and products of photosynthesis. Compare the role of a leaf to a factory. These logical parallels can be extended to transport as a life function related to nutrition.

5. Use models and transparencies of organisms to trace the path of food through representative systems. Compare extra- and intracellular digestion by using evolutionary trends found in organisms.

A. Autotrophic

Performance Objectives

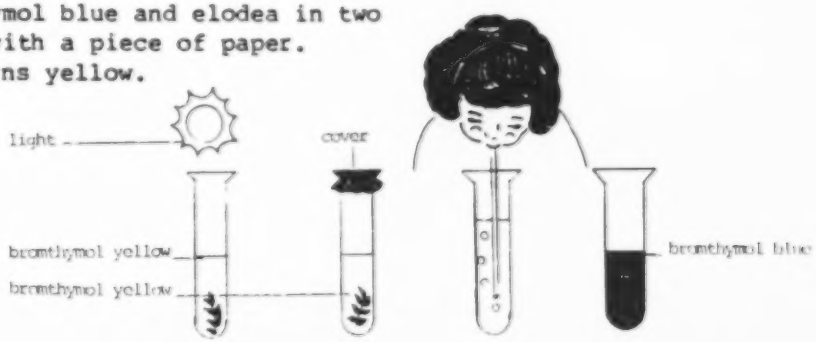
Students will be able to

- outline the essential steps that green plants use to convert radiant energy to chemical bond energy.
- write a balanced equation for photosynthesis which incorporates the knowledge of photolysis.
- diagram the structure of the leaf and identify the function of each structure.
- (Extended) summarize the process of photosynthesis using light and dark reactions.

Activities

1. [D,L] Plants as sugar factories -- Display a piece of pure sugar cane. Ask a student to come up and taste this product. How was the sugar cane produced? Define organisms that manufacture their own food as autotrophic forms of life.

2. [D,L] Photosynthesis and CO_2 -- Place brom-thymol blue and elodea in two test tubes. Place one in sunlight and cover one with a piece of paper. Explain why the fluid in the covered test tube turns yellow.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

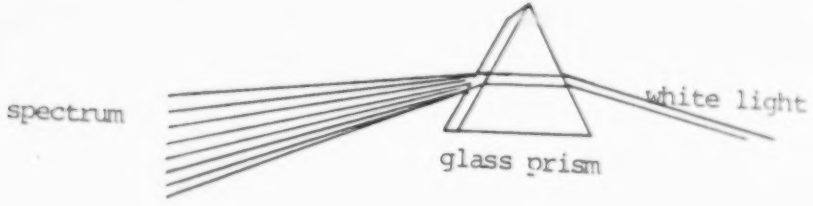
3. [D] Plant photosynthesis -- Place the test tube with brom-thymol yellow in sunlight. Explain why the blue color returns.

4. [D] Global photosynthesis -- Use a map or globe of the world. Ask your students to indicate where they think most of the world's photosynthesis occurs. Your students will probably point to the tropical rain forests. Explain why 80 percent of photosynthetic activity occurs in the open ocean because of unicellular algae.

5. [D,L] Photosynthesis and 0_2 -- Place indolphenol, spinach chloroplasts, and phosphate buffer in two test tubes. Expose one test tube to a source of light. Cover the other with aluminum foil. Why does the indolphenol in the test tube exposed to light lose its color? (The indolphenol is reduced by liberated 0_2, is bleached and loses color.)

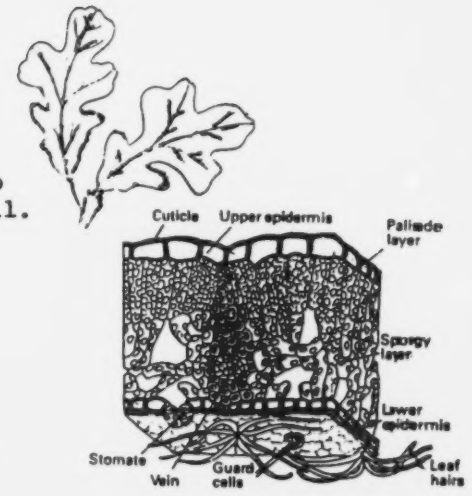
6. [L] Movement of chloroplasts -- The movement of chloroplasts may be observed by viewing a fresh leaf of elodea under a microscope.

7. [D,L,P] Light and photosynthesis -- Ask students to develop an activity which tests for the following hypothesis: If light is necessary for photosynthesis, will twice as much light double the rate of photosynthesis? You may also have students test for different color lights.



Activities (continued)

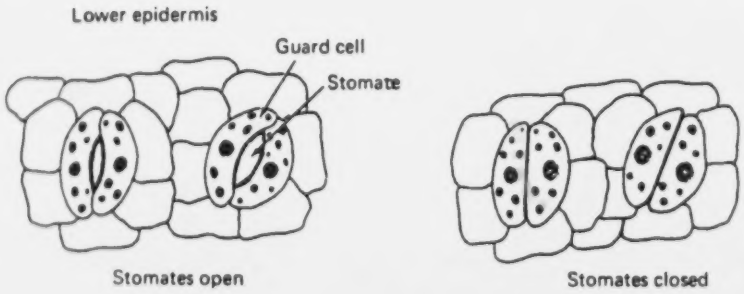
8. [D,L] Test for starch production in leaf -- Extract chlorophyll from leaves that have been partially covered with cork or use variegated coleus to show the lack of starch production in sections that do not contain chlorophyll.

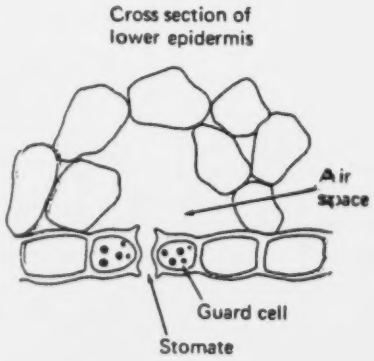


9. [D,L] Lab: Cross section of leaves -- Observe prepared slides of cross sections of leaves and compare them to the three-dimensional view of a leaf model.

10. [D,L] Water and upper epidermis -- Pour water on wax begonia leaves and elicit the value of the waxy upper epidermis surface (cuticle layer).

11. [D,L] Guard cells in leaf -- Strip a thin membrane from a lettuce leaf (also tradescantia leaves) and use the microprojector to view stomata. Explain the function of these openings. Apply the concept to adaptations of various types of plants.





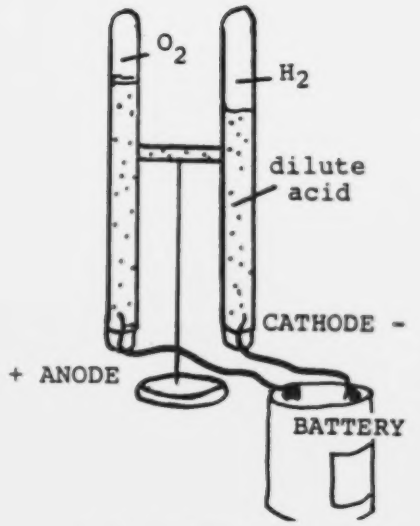
12. [D,L] Comparison of leaf to factory -- Ask students to compare the parts of a leaf to a factory located in a big city. Use structural comparisons to total function of the leaf as a manufacturing center.

Key: **D** = demonstration, **L** = laboratory lesson, **R** = report, **S** = speaker, **P** = project

Activities (continued)

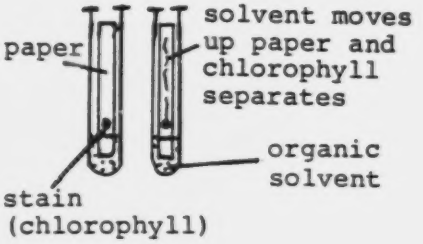
13. [D] Charts, models--plant structures -- Charts, models, microscopic slides, and sections on various vegetative structures.

14. [D,L] Hoffman apparatus -- Demonstrate the Hoffman apparatus. The object is to allow students to understand that water can be split into component elements through the use of energy. Relate electrolysis to photolysis. 4]



15. [D] Photographic paper -- Obtain a number of sheets of unexposed photographic print paper. Expose to the light and view the chemical changes that occur.

16. [D,L] Chromatography -- Perform a paper chromatography demonstration or lab lesson to show various pigments in a green leaf.



17. [D] van Helmont's experiment -- Read about Johannes van Helmont's research on the willow plant. Ask students to suggest the controls that were applied in that experiment. How do his results apply to our understanding of photosynthesis?

18. [D] Chlorophyll and photosynthesis -- Demonstrate the absorption of light by chlorophyll using a test tube filled with chlorophyll extracted from spinach leaves. Use a concentrated beam of light and project the beam of white light through the test tube and onto a screen.

B. Heterotrophic

Performance Objectives

Students will be able to

- define and compare the processes of ingestion, digestion (chemical and physical), and egestion.
- list the building blocks of fats, proteins, and carbohydrates.
- describe the process of heterotrophic nutrition found in the representative animals and plants (organisms) as listed for selection throughout the syllabus.

Activities

1. [D,L] Digestion in the mouth -- Pass out crackers (unsalted) to each member of the class. Ask them to chew slowly and report any changes in the taste of the cracker. Elicit the steps in the process of chemical and physical digestion.

2. [D] Mold, bacteria -- Display bread molds, mushrooms and bacterial cultures. Students should recognize the heterotrophic mode of nutrition. [Caution: Throughout this manual, where reference is made to the use of mold, be advised that some students may be allergic to mold exposure; distribute very small portions.]

3. [D,L] Starch agar and bread mold -- Inoculate bread mold spores on starch agar; wait approximately one week and test for starch digestion.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

4. [D,L] Chemical digestion in the mouth -- Have students use their tongues to feel the bumps behind their incisor teeth (on the gum). Ask what function these bumps might be performing. (They are salivary ducts.) Elicit the purpose of these glands.

5. [D,L] Absorption of food -- Demonstrate, using a microprojector, a prepared slide of a villi. Have the class discuss the role of villi. Demonstrate the value of increased surface area by making a fan with a folded piece of paper.

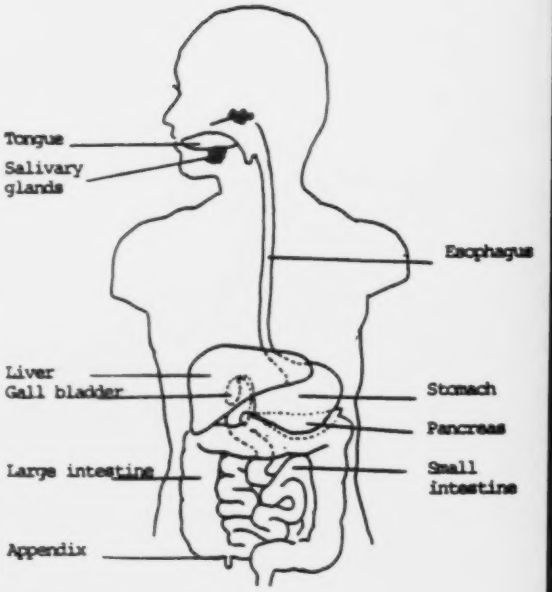
6. [D,L] Pathway of food -- Use a mannequin to trace the pathway of food through the human digestive system. Compare, using the appropriate models, with protozoa, hydras, earthworms, and grasshoppers.

7. [D,L] Hydrolysis and synthesis -- Use magnetic models of organic molecules to demonstrate hydrolysis and synthesis. Discuss the purpose for hydrolysis and synthesis in living organisms.

8. [D,L] Bread mold -- Prepare test tubes containing bread, water, paper, and dust gathered from the various places in the room. After each class day, allow visual checks for growth. After growth has occurred, use the microprojector to view and identify the structures of the bread mold. Explain how the identified structures allow the mold to obtain nutrients.

Caustic Substance

9. [D,L] Gastric digestion -- Take the white portion of a hard-boiled egg and place it into three test tubes, one containing pepsin suspension (0.5 percent) and hydrochloric acid (0.2 percent), the second containing pepsin plus hydrochloric acid (0.2 percent), and the third distilled water. Place the test tubes into an incubator set at 37°C. Record results for a few days. In addition, use an additional test tube containing pepsin, egg white, and sodium carbonate (0.5 percent) solution. Compare the results to the acidic solution.



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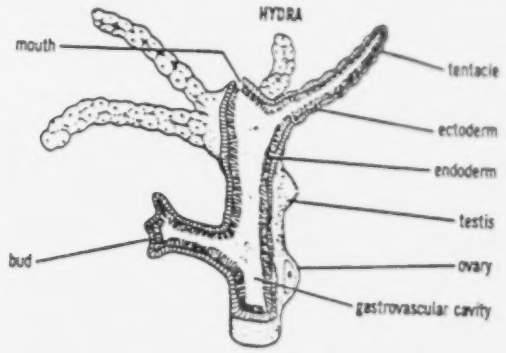
10. [D] Insect digestion of crops -- Show a filmstrip depicting insect damage to crops. Explain the success of insects in their competition with man for food.

11. [D,L] Unripened banana/chemical digestion -- As an alternative to chewing a piece of bread, have students chew a green banana for a period of time and note the change in flavor (about two to three minutes). Compare the taste of the green banana with a well-ripened banana.

12. [D,L] Hydra feeding observation -- Under ideal conditions, feeding hydras in a culture media with brine shrimp or daphnia will clearly illustrate the ingestive and digestive mechanisms of this specimen.



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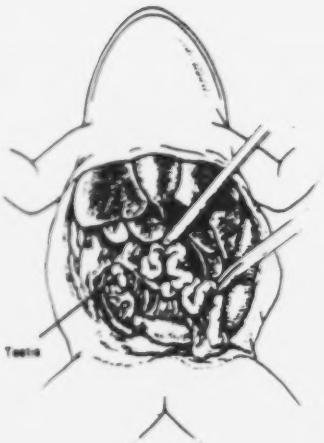
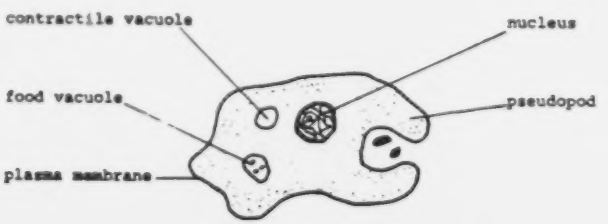
Activities (continued)

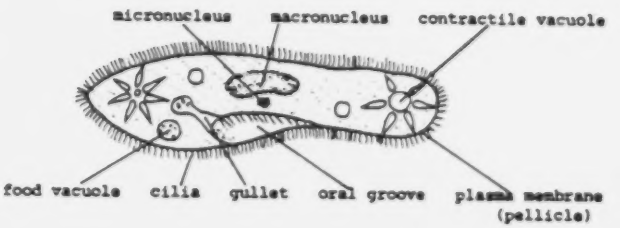
13. [D,L] Animal dissection -- Display dissected specimens of a grasshopper, earthworm and frog. Ask students to identify the structures of each and compare similarities and differences among them.



14. [D,L] Live crickets feeding habits -- Live crickets are relatively inexpensive - 5 cents to 25 cents and are available in most pet stores throughout the year. Place them in a terrarium and observe their feeding habits. Make sure there is enough vegetation so that students can explain the sometimes damaging effects of insects on crops.

15. [D,L] Protozoan feeding activity -- Use a film loop to show amoeba and hydra feeding. Feeding habits of paramecia can be shown using carmine stain. Paramecium will ingest carmine particles.





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Topic 2: *Transport*

Pages 27 to 31

Suggested time: 5 to 9 days

Topic Theme: The ability to absorb and circulate digested materials is necessary for the performance of metabolic activities of cells. Each organism has evolved structures that enable it to meet the process of transport. Transport of materials includes the movement of molecules through membranes, intracellular circulation, and intercellular circulation. Multicellular animals have adapted vascular systems which include open and closed types.

Teaching Strategies: *An Overview*

The process of absorption and transport at the cellular level is applied to multicellular organisms. As multicellular organisms evolved, more complex structures and systems became necessary to provide efficient transport of vital materials. Representative organisms provide a wide variety of examples of adaptation for this life function.

Teaching Strategies: *Sequential*

1. Knowledge of the structure of the cell membrane is essential for developing an understanding of transport in all organisms. Students should understand that transport occurs through thin, moist membranes. The dynamic nature of cells performing transport can be seen in the direct observation of the changes in the elodea cells exposed to hypertonic and hypotonic solutions. A microprojector can provide the whole class with the view of the processes of transport in cells.

2. The concepts of active and passive transport can be taught by utilizing demonstrations which involve varying concentrations of molecules. Styrofoam balls of different colors moving in a plastic box, colored solutions moving through membranes, and other demonstrations can stimulate the discussion of energy (potential and kinetic) as it relates to movement of molecules.

3. To teach plant adaptations for transport, recall knowledge of the leaf and stem structure.

4. The circulatory systems of representative animals should be taught with an emphasis on evolutionary developments related to the transport of material in unicellular and multicellular organisms. A circulatory system in multicellular animals is required because most of its cells are not in direct contact with the environment. Compare the open and closed circulatory systems of grasshoppers and earthworms.

A. Process

Performance Objectives

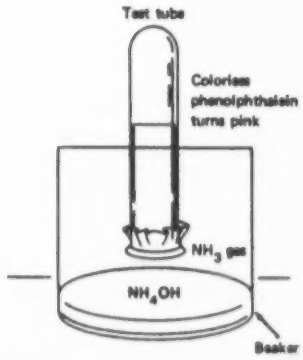
Students will be able to

. define the term absorption.
. relate the structure of the cell membrane to the process of absorption.
. distinguish between active and passive transport.
. compare inter and intracellular transport.

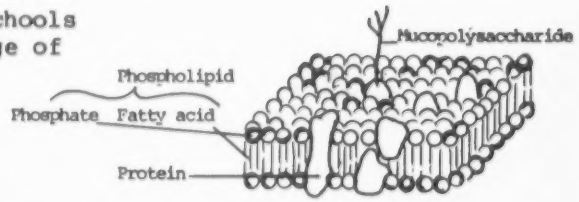
Activities

Dangerous Vapors

1. [D,L] Diffusion of a gas through a membrane -- Open a bottle of ammonium hydroxide and allow the vapors to diffuse through the air in the room. Demonstrate the diffusion of ammonia gas through a moist membrane that encloses a test tube filled with a filter paper strip impregnated with phenolphthalein. Teacher may wish to substitute an open bottle of "inexpensive," "flowery" perfume instead of ammonium hydroxide. Spraying the front of the classroom with a room deodorizer is still another alternative.



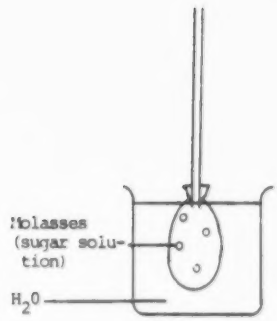
2. [D] Demonstration of fluid--mosaic model of cell membrane -- Prepare a gelatin mold into which grapes or marbles have been suspended. Compare this model to the classic view of the Daniell cell membrane. Ask students to compare selective permeability of pores and charged molecules to the selection process in getting a job. Ask if all students (molecules) applying to schools (entering cells) are equal. Relate differences in size, shape, and charge of molecules to proteins, fats, and carbohydrates.



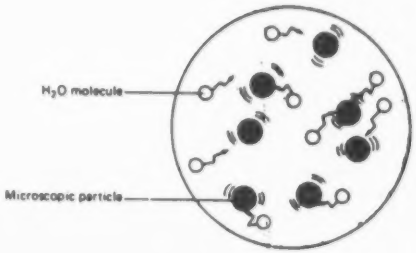
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

3. [D,L] Diffusion -- Demonstrate the transport of water and glucose through a membrane using an inverted thistle tube placed in a beaker of water. Elicit the concepts of differential movement of water, dissolved small molecules, and other larger molecules.

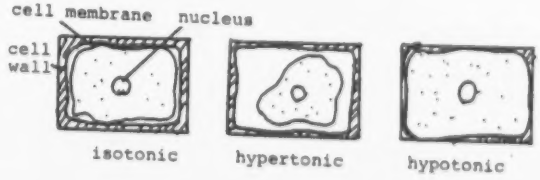


4. [D,L] Brownian movement -- Use a microprojector to demonstrate brownian movement. Elicit the concept of energy as it relates to active and passive transport. Any fine particle that is not soluble in water will work, e.g., pepper, chalk dust, etc.



5. [D,L] Active transport -- Discuss energy (potential and kinetic) using a book lifted and dropped from different heights. Relate the sounds of collision to the degree of conversion of potential to kinetic energy.

6. [D,L] Plasmolysis -- Use elodea to demonstrate plasmolysis in hypertonic solutions (salt and water).



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

B. Adaptations

Performance Objectives

Students will be able to

- identify the types of vascular tissue in plants.
- describe the theories of transport in plants.
- trace the transport of materials throughout the plant.
- describe and compare the systems of transport in protozoa, coelenterates, annelids, and arthropods.
- trace the evolutionary development of transport systems in multicellular animals.

Activities

Plants

1. [D,L] Transport -- Demonstrate transport in a celery stalk placed in red dye. Compare this to pictures of a water tower and a sequoia tree. Prepare this demonstration several hours or the day prior to the lesson.

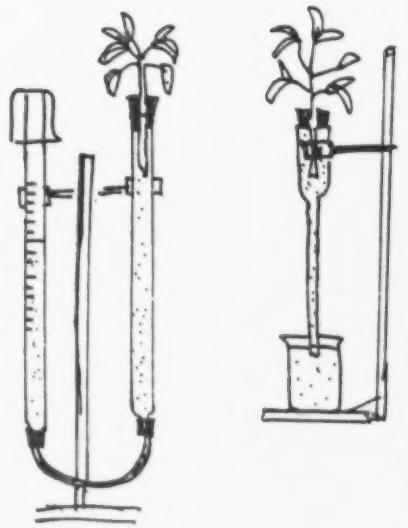
2. [D,L] Relation of cell to function -- Use a microprojector to show slides of root hair cells, xylem cells, phloem cells and guard cells. Elicit the relationship of these structures to their special functions.

3. [D,L] Relation of size of organism to vascular systems -- Display (using a dissecting microscope or an overheard projector) examples of carpet moss, haircap moss, fern, and liverwort. Ask students to relate the size of these organisms to the type of vascular systems they utilize.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

4. [D,L] Transpiration pull theory -- Make a potometer, as illustrated, to measure loss of water due to transpiration. The apparatus is filled with water. One end is plugged with a hole stopper through which a coleus plant stem is inserted. The stopper is sealed with paraffin. A beaker is inverted over the other end and the apparatus is clamped to two ring stands. Students should compare water loss in the apparatus containing a test tube with leaves to one with no leaves.

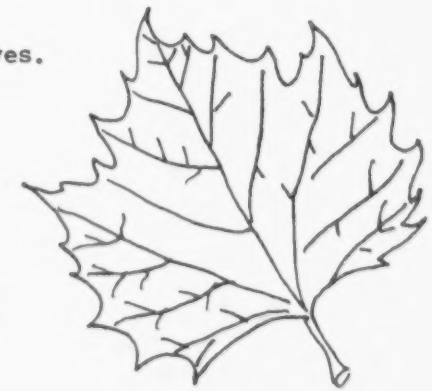


5. [D,L] Transpiration -- Place cobalt chloride paper on both surfaces of a leaf. Explain why the paper on the lower epidermis turns pink.

6. [D,L] Roots -- Display the root structure of newly sprouted radish seeds. Relate this observation to the precautions used in transplanting leaves.

7. [D,L] Roots and survival -- Display and compare roots of dandelion plants and lawn grass. Why do dandelions replace lawn grass?

8. [D,L] Leaves -- Display and compare various dicot and monocot leaves. List differences and similarities.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

Animals

1. [D,L] Exercise and heartbeat -- Have students take their pulse before and after exercise. Demonstrate the use of a stethoscope.

2. [D,L] Drugs and circulation -- Obtain daphnia from a pet store and observe heartbeat and circulation. Further observations might include the effects of caffeine and aspirin on heartbeat.

3. [D,L] Parts of the heart -- Dissect a sheep heart and identify the various structures.

4. [D,L] Circulation in humans -- Have students read William Harvey's paper and compare his methods and results with modern research and findings on circulation. Discuss various diets and effects of cholesterol on heart disease.

5. [D,L] Blood cells -- Examine and compare red blood cells of frog and human. Interpret the evolutionary significance of hemoglobin in annelids and vertebrates.

6. [D,L] Dissection--lobster or crayfish -- Dissected lobsters and crayfish display much the same organs as do grasshoppers. The dorsal heart is much more visible than in the grasshopper.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 3: *Respiration*

Pages 32 to 37

Suggested time: 5 to 8 days

Topic Theme: Organisms must use energy. Chemicals in food contain potential energy stored in bonds. Respiration provides usable energy for metabolic activities. Different organisms obtain different amounts of energy depending on their use of various enzyme systems and the use or lack of use of free oxygen. Both plants and animals perform respiration and produce high energy molecules of ATP.

Teaching Strategies: *An Overview*

Students should be able to distinguish between internal (cellular) and external (breathing) respiration. The process of cell respiration is a complicated one. Basically the student should realize the efficiency of aerobic over anaerobic respiration. Comparing the energy requirements of primitive bacteria to complex multicellular organisms should be related to the evolutionary changes in the production of energy. The extended area in biochemistry details the biochemical pathways in anaerobic and aerobic phases. The goal is to teach the process of obtaining energy. Larger amounts of energy are obtained in aerobic respiration because a six-carbon compound, glucose, is broken down to six one carbon compounds of CO_2.

Teaching Strategies: *Sequential*

1. Review the process of diffusion through cell membranes. Aerobic respiration at the cellular level must involve a process of absorption of oxygen.

2. Obtaining energy from food should be taught as a process of converting one form of chemical bond energy to a usable form of energy (ATP). Organisms that use oxygen can obtain more energy than those which do not. The evolution of specific enzyme systems to catalyse reactions should be related to the processes of anaerobic and aerobic respiration. The processing of a six-carbon molecule of glucose to many intermediates should be related to a comparison of energy produced in anaerobic and aerobic respiration. A comparison of burning (of a peanut for example) with slow oxidation in cells is helpful. A comparison of the methods of energy produced by an atomic bomb and an atomic reactor is helpful. Elicit the idea that energy may be obtained usefully through a series of small steps.

3. (Extended) The chemical equations relating the phases of anaerobic and aerobic respiration can be taught by emphasizing the basic process of the breakdown of glucose (also relate the use of fats and proteins that can enter the Krebs cycle at the acetyl-coenzyme A level). The suffix "lysis" should be defined by students as a breaking up of a molecule. Compare glycolysis to hydrolysis. Relate the structure of the mitochondrion to the Krebs cycle and hydrogen transport.

4. Describe the structures used by organisms to obtain and utilize oxygen.

5. All organisms exchange gases through moist, thin membranes. The trends evident in the evolution of these representative organisms should be stressed.

A. Process

Performance Objectives

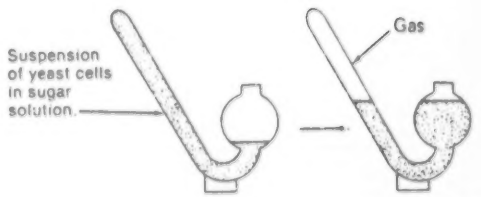
Students will be able to

- describe the chemical reactions involved in the production of energy by anaerobic and aerobic respiration.
- interpret the evolutionary significance of anaerobic and aerobic forms of respiration.
- (extended--biochemistry.) recall the individual steps in the process and phases of anaerobic and aerobic respiration.

Activities

1. [D,L] Kinetic energy -- Arrange (steel) marbles on two toy tracks bent into a "v" shape. Drop marbles down and measure kinetic energy change. (Books raised to a height and dropped can be substituted.)

2. [D,L] Fermentation in yeast -- Test for alcohol in fermentation by pouring 5cc of the fermenting glucose solution into a test tube. Add a few drops of 10 percent NaOH and add potassium iodide solution by drops. The liquid that remains yellow forms the iodoform layer with any alcohol present.



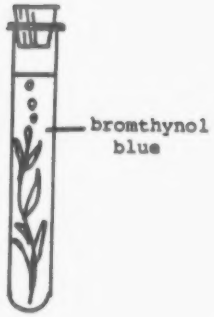
Activities (continued)

Safety Glasses

Fire

3. [D] Respiration-burning -- Place a lump of sugar on a wire gauze. Try to burn it with a Bunsen burner. Explain why it melts and does not burn. Place cigarette ash on the lump of sugar. Elicit concepts of catalytic action.

4. [D] Yeast fermentation -- Set up a yeast fermentation tube. Smell what is produced; observe what happens to the level of liquid in the tube.



5. [D] Plant respiration - Plant excretion of carbon dioxide may be displayed or demonstrated by placing a plant in a closed test tube containing bromthymol blue. Place in dark and in light. Compare the results.

6. [D,L] Aerobic respiration -- Have a student breathe onto a chalkboard to observe condensation. Compare water vapor to liquid water.

7. [D,L] CO_2 and Respiration -- Have a gauze bag of germinating seeds suspended in a jar above limewater solution. Ask students to observe changes and explain.

8. [D,L] Earthworm respiration -- Use an earthworm culture and observe activity of the organism in hot, dry air and moist, cold air. Elicit the function of membranes for absorption of O_2.

9. [D,L] Respiration in protozoa -- Demonstrate activity of paramecia in water that is high in CO_2 and another sample of high O_2 levels.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

B. Adaptations

Performance Objectives

Students will be able to

- discuss the role of guard cells in obtaining gases in plants.
- summarize gas exchange in all organisms as diffusion through thin, moist membranes and compare the respiratory structures of the representative animals.

Activities

1. [D,L] Lung -- By use of a pump and eyedropper, aerate sections of a haslet obtained from a butcher.

2. [D,L] Diffusion through a membrane -- Using a test tube containing paper soaked with phenolphthalein, demonstrate the diffusion of ammonia through a moist and a dry dialyzing membrane.

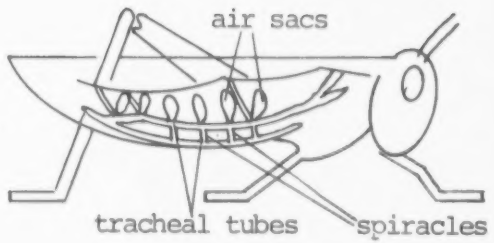
3. [D,L] Diffusion in stems -- Display twigs showing lenticels.

4. [D,L] Diffusion in stomates -- Use the microprojector to view stomata in a leaf. (tradescantia, lettuce)

Activities (continued)

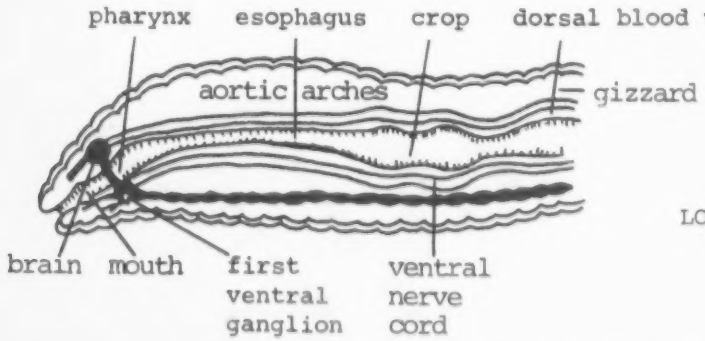
5. [D,L] Guard cell function -- Use two bicycle tire tubes and demonstrate one full and one empty to compare to guard cell activity.

6. [D,L] Grasshopper respiration system -- Distribute preserved specimens of grasshoppers. Ask students to identify the spiracles and interpret their use.



7. [D,L] Vital capacity of lungs -- Ask students to determine the vital capacity of their lungs by breathing into respirometers. These plastic containers can be used to compare volumes of exhaled air of smokers and nonsmokers.

8. [D,L] CO_2 effect on earthworms -- Anesthetize living earthworms by placing them in a container filled with soda water which renders the specimens unconscious. Remember soda water is CO_2 dissolved in water.



LONGITUDINAL SECTION

9. [D,L] Currency analogy to ATP -- Display different types of currencies. If monies are not available, then label index cards appropriately: lira, pound, etc. The New York Times often carries exchange rates for currencies. Use the analogy of exchanging one form of currency for another with ATP formation.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 4: *Excretion*

Pages 37 to 39

Suggested time: 4 to 7 days

Topic Theme: Organisms produce metabolic wastes and should remove those which are toxic. Some of these wastes are converted to less toxic forms before they are removed. Others can be retained or recycled.

Teaching Strategies: *An Overview*

The concept that most metabolic wastes are toxic and should be removed is essential to an understanding of the dynamic nature of living organisms. Metabolic wastes should be distinguished from undigested waste. Different organisms, those living on land, have had to modify nitrogenous wastes before removal from the body. This coincides with the evolutionary process of transition from water to land habitation.

Teaching Strategies: *Sequential*

1. List the metabolic wastes produced from respiration and dehydration synthesis.

2. The specific systems used by animals for excretion of toxic wastes can be taught by comparing the problems faced by unicellular and multicellular organisms in the removal of waste products.

Performance Objectives

Students will be able to

- list the metabolic waste products and the processes that produce them.
- compare the treatment of nitrogenous wastes in plants and animals.
- compare the modification of nitrogenous wastes in unicellular and multicellular organisms.
- describe the types of excretory systems found in the representative animals. relate the structure of excretory organs to their function.

Activities

1. [D,L] Perspiration and evaporation -- Use a student volunteer to demonstrate evaporation of alcohol from the skin. Discuss the role of perspiration.

2. [D,L] Composition of exhaled air -- Have students breathe into a test tube filled with brom-thymol blue. Interpret the results.

3. [D,L] Interrelation of organisms -- Use an aquarium with fish, plants, and snails. Elicit the interrelationships that exist between these organisms. Ask what would happen if the plants were removed from the tank.

4. [D,L] Sugar test in urine -- Test urine samples for glucose by placing 5 cc of Benedict's qualitative solution and eight drops of urine in a test tube. Boil for two minutes and cool. Alternative activity: Clinitest tablets; students interpret results from color chart.

Activities (continued)

5. [D,L] Exhaled air -- Distribute mirrors to students and ask them to breathe on the glass. Ask what vapors are being given off. What processes result in the production of water? Teacher may wish to conduct the same demonstration by having students exhale on the board.

6. [D,L] Composition of urea -- Dissolve urea in water and add urease. Test for ammonia (phenolphthalein). Describe the differences between ammonia and urea.

7. [D,L] Feedback -- Display a schematic drawing of a thermostat. (Alternative-toilet tank.) Demonstrate the cyclic nature of the diagram and ask students to relate the feedback system for temperature control in man.

8. [D,L] Nephron structure -- Compare the nephron to a filter in a funnel. Indicate the difference between a passive filter and the nephron.

9. [D,L] Malpighian tubule -- Use a piece of coiled red string inserted into a thistle tube to represent a malpighian tubule. Discuss filtration and reabsorption.

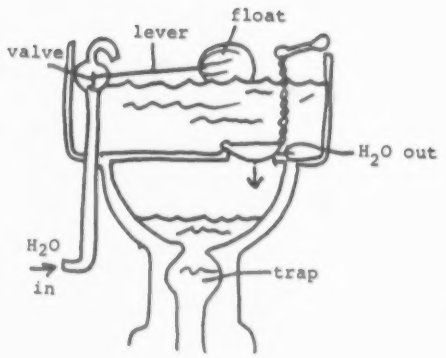
10. [D,L] Temperature regulation in skin -- Have jars of cold and hot water available. Ask students to dip a hand in each jar (preferably with a ring on each hand) and notice changes in size and appearance when hand is withdrawn. Under what conditions may the ring be removed with the least difficulties.

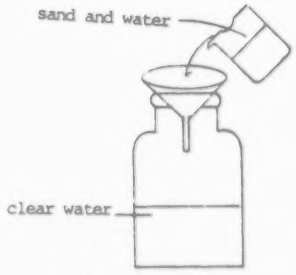
11. [D,L] Dialysis -- Show pictures of a dialysis machine. Explain how dialysis works and compare it to normal kidney function.

12. [D,L] Calf's kidney -- Display a calf's kidney which has been cut longitudinally. Ask students to describe the structures they see and relate them to excretory function.

13. [D,L] Active transport in paramecia -- Use a microprojector and demonstrate the function of the contracting vacuole. Proto-sio or capturing protozoa between strands of cotton should be used so that we can focus directly on contractile vacuole.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project





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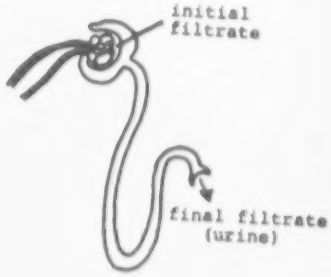


Topic 5: *Regulation*

Pages 39 to 43

Suggested time: 5 to 8 days

Topic Theme: Organisms must have the ability to receive and respond to stimuli from their internal and external environment. Regulation is shared by a nervous and endocrine system in animals and achieved by an endocrine system in plants.

Teaching Strategies: *An Overview*

Describe how organisms react with their internal and external environment to maintain a homeostatic balance.

Teaching Strategies: *Sequential*

1. Demonstrate "trophic" response of protozoa (paramecium is the preferred organism) to sunlight and pH (vinegar). List the activities and ask students to explain why a coordinating system should be available. Demonstrate simple reflex response (knee jerk, blinking).

2. A simple electric circuit (wire, switch, light source, or bell) could be related to definitions listed on page 40 in the syllabus. Differences should be stated.

3. Compare behavioral characteristics of the hydra, earthworm, grasshopper, and man. Allow students to deduce why one organism is capable of limited responses, whereas another demonstrates complex movements and responses. For instance, the general response of the hydra, compared with the sophisticated movement and response in the grasshopper.

4. Prior to the section devoted to chemical control have your lab specialist prepare plant specimens that display a variety of tropisms. For instance, coleus grown on a window sill will, within a week, orient its leaves toward the window. Compare plant development when buds are pinched off as opposed to growth without pruning. Make use of colored chalk to trace the site of auxin production and its eventual position after exposure to light and gravity. Bring to class a variety of fruits. Explain how farmers influence ripening so that fruits may be picked and transported at different times during the year.

5. Display or review the metamorphosis of a butterfly or moth. How is the timing from larvae to pupae stage regulated? (Refer to juvenile hormone present in many insects undergoing complete metamorphosis.) Compare chemical control in animals with nerve control. A chart listing similarities and differences is useful. Explain the role of the circulatory system in the distribution of these hormones. Display vials or containers of insulin. Note that the insulin has been purified from either pig or beef pancreases. Commonality of hormones among animals should become evident.

A. Nerve Control

Performance Objectives

Students will be able to

- describe the transmission of impulses in a neuron.
- relate current knowledge of drug use to chemicals found in the nervous system.
- relate the order of increasing complexity of nervous systems to the maintenance of homeostasis and control of life functions.

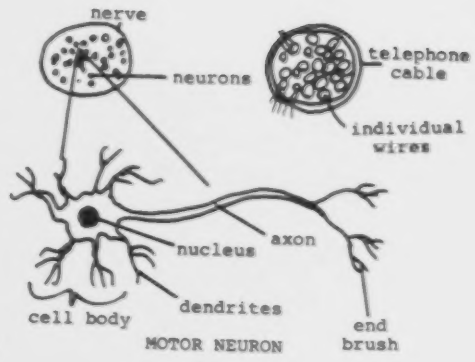
Activities

1. [D,L] Nervous system function -- Have the students in the class make a written record of every sound heard for one minute. Ask them to report these sounds while blindfolded. Evaluate the function of our nervous system in responding to and recording stimuli.

2. [D,L] Coordination of activity -- Blindfold a student and ask him/her to tie a shoe lace, unbutton a button, or pick up a ticking clock. Ask them to describe how they were able to perform the tasks.

3. [D,L] Structure of nerves -- Show a model of a neuron, a sample of a telephone cable, a ganglion, and a brain. Ask them to determine the order of increasing complexity.

4. [D,L] Drugs and nerves -- Discuss Loewi's experiments with frog hearts. Ask students to describe the affect of drugs like barbiturates, nerve gas, and amphetamines on metabolic activity.



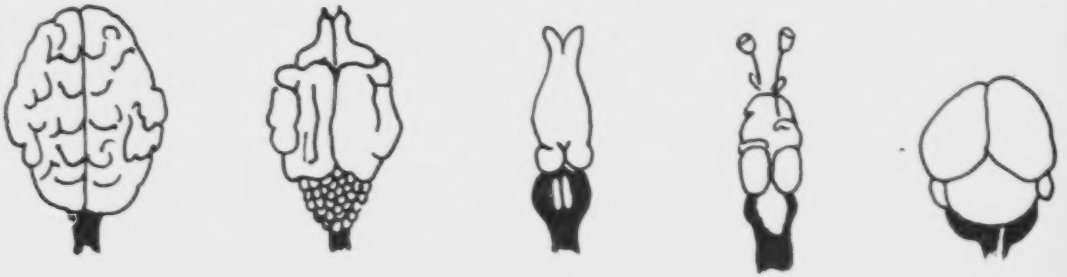
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

5. [D,L] Human spinal cord -- Discuss the spinal vertebrae using an articulated human skeleton.

6. [D,L] Simple responses -- Use a microprojector (or a film loop on hydra) to demonstrate how hydra or paramecia respond to stimuli.

7. [D,L] Comparative nervous systems -- Show models of the representative animals and describe simple activities dependent on a functioning nervous "system."



HUMAN HORSE ALLIGATOR FISH BIRD

8. [D,L] Nervous systems -- Use models and charts to compare the nervous systems of the earthworm, grasshopper, and man.

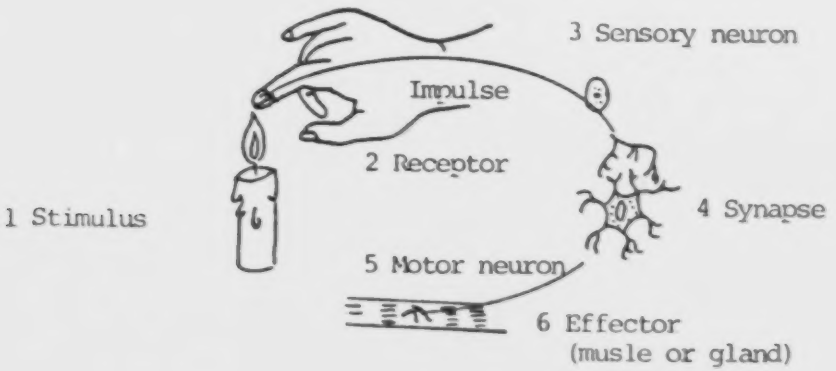
9. [D,L] Insect activity -- Describe activities of a cockroach using a large, greased Syracuse jar. The animal can be viewed easily because lubricating the inside of the jar with a light coat of Vaseline will prevent its escape.

10. [D,L] Grasshopper anatomy -- Use a preserved specimen of a grasshopper to show parts of the body (e.g., eyes) involved with nervous regulation (tympanic membrane).

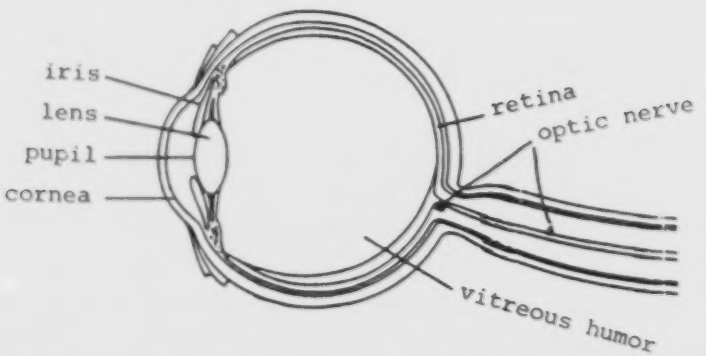
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

11. [D,L] Reflex action -- Use patella hammer to elicit the pathway of the reflex arc. Relate movement of students when the period bell rings to Pavlov's experiments with conditioned reflexes.



12. [D,L] Ear and eye -- Show models of ear and eye. Elicit the neuron pathways involving these structures.



B. Chemical Control

Performance Objectives

Students will be able to

. describe the mechanism of tropic responses in plants.
. compare the function of a nervous system to an endocrine system.
. compare hormone control in representative animals.

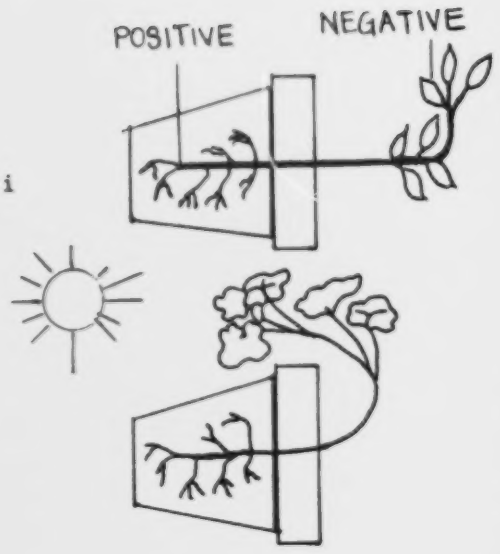
Activities

1. [D,L] Movement in plants -- Demonstrate the nastic movement of sensitive mimosa. (Be sure to note that this is not hormonal, yet it is good to show a plant movement that can lead to a discussion of tropic movements.)

2. [D,L] Hormonal effect on seedling growth -- Show growth of seedlings in response to auxins and gibberellins.

3. [D,L] Algae response to light -- Place a heavy culture of algae in a Petri dish half covered with dark paper. Ask students to record and explain the growth in each semicircular area.

4. [D,L] Tropisms -- Turn a potted plant on its side and record growth of stems, leaves, and roots after a few days.

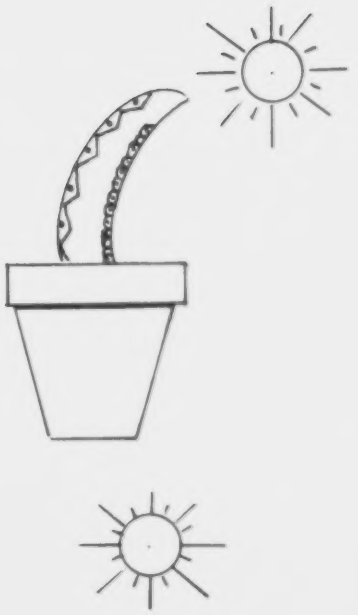


Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

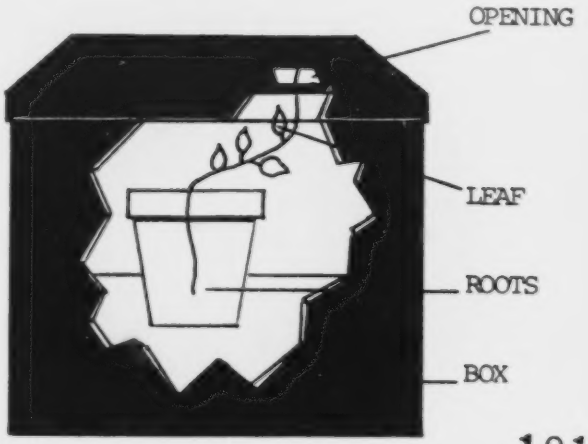
5. [D,L] Tropisms -- Plan a field trip around the school to observe tropic responses of ivy, grapevines. If not possible, use a terrarium.

6. [D] Phototropism -- culture dish rotation -- Rotate culture dishes or pots containing new shoots a number of times each day. Observe movement of shoot in response to exposure to light.



7. [D] Synthetic auxins -- Display a container of Root-Gro (commercial auxins used for stimulating root growth in plant cultures). Read directions and relate to natural auxin control.

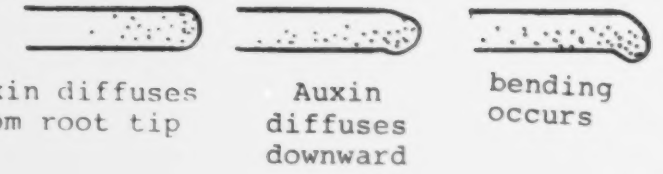
8. [D] Phototropism - bean germination -- Begin germination of bean seeds in a box containing a single opening. Observe direction of growth.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

9. [D] Hydrotropism -- Place seeds on blotter paper/glass apparatus. Students should be asked to explain growth of roots apparently against the agent of gravity towards the water.

9a. [D] Geotropism -- Grow plant cuttings in three test tubes -- one upright, one upside down and one lateral.



10. [D,L] Insulin and humans -- Distribute a set of news articles on recombinant DNA and insulin production.

11. [D,L] Experiments with hormones -- Discuss transplantation of islet cells. Relate Banting's experiments with insulin to the role of hormones in human systems. This discussion, as with other references to discussion in the guide, should be preceded by library research.

12. [D,L] Pheromones -- Discuss how pheromones may be used to trap bugs. (Display bag-a-bug traps and discuss "sterile male technique" for insect control.)

13. [D,L] Human growth and hormones -- Display pictures of P.T. Barnum's giants and midgets. Discuss role of hormones.

14. [D,L] Sex lure traps for insects -- Display sex lure traps for insects. Ask students to relate to regulation.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 6: *Locomotion*

Pages 43 to 44

Suggested time: 3 to 5 days

Topic Theme: Locomotion is required in many cases to obtain food, seek shelter, and escape from predators. Organisms have adapted different structures for locomotion.

Teaching Strategies: *An Overview*

The uses of locomotion for survival are obvious to students. The unique methods of protozoan, coelenterate, arthropod, and human movement are fascinating.

Teaching Strategies: *Sequential*

1. Display a variety of animal skeletons. Ask your students to compare each and describe a characteristic related to the animals' ability to move about (brachiation in some monkeys; rapid running and leaping in cats). Students should list the problems an animal has in terms of survival if the animal's ability to move is limited or destroyed.

2. Allow your students to observe a variety of prepared slides or student slides of protozoa. Be sure to select protozoa that exhibit different kinds of locomotion., e.g., cilia, flagella. Euglena is easily observed magnified 400 times, however, the flagellum is not visible. Its movement, however, may be inferred and visualized by use of a chart. Similar representations should be made for the hydra. Somersaulting movements of hydra are usually not visible. Ample illustrations, however, are readily available.

3. Students should study preserved specimens of the earthworm and grasshopper to observe and compare modality of movement. It is most desirable to have live specimens of each so students can visualize the specific activity. Pet stores often have "crickets" throughout the year; most science suppliers stock specimens well into the fall.

4. Display a human skeleton and compare skeletal structure in the human with the skeletons of animals previously displayed. Colored ribbon or plastic may be strategically placed at points on the bone to show the interaction of muscles.

Performance Objectives

Students will be able to

- list specific structures for locomotion found in the representative organisms and compare their function.
- evaluate the evolutionary significance of mechanisms of locomotion.
- relate locomotion to the ability of an organism to survive.

Activities

1. [D,L] Locomotion -- Use a microprojector to demonstrate locomotion in various forms of aquatic life.

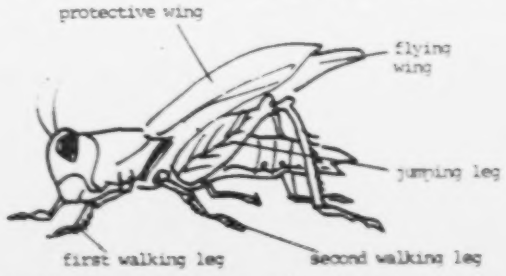
SOMERSAULTING HYDRA

LOCOMOTION IN EUGLENA

Activities (continued)

2. [D,L] Earthworm locomotion -- Use an overhead projector to display an earthworm's movement in a large Syracuse jar.

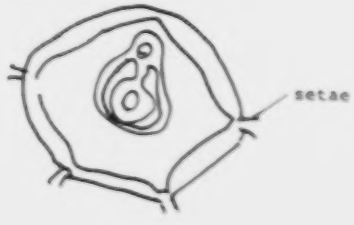
3. [D,L] Insect locomotion -- Place a cricket in a Syracuse jar to observe patterns of coordinated movement.

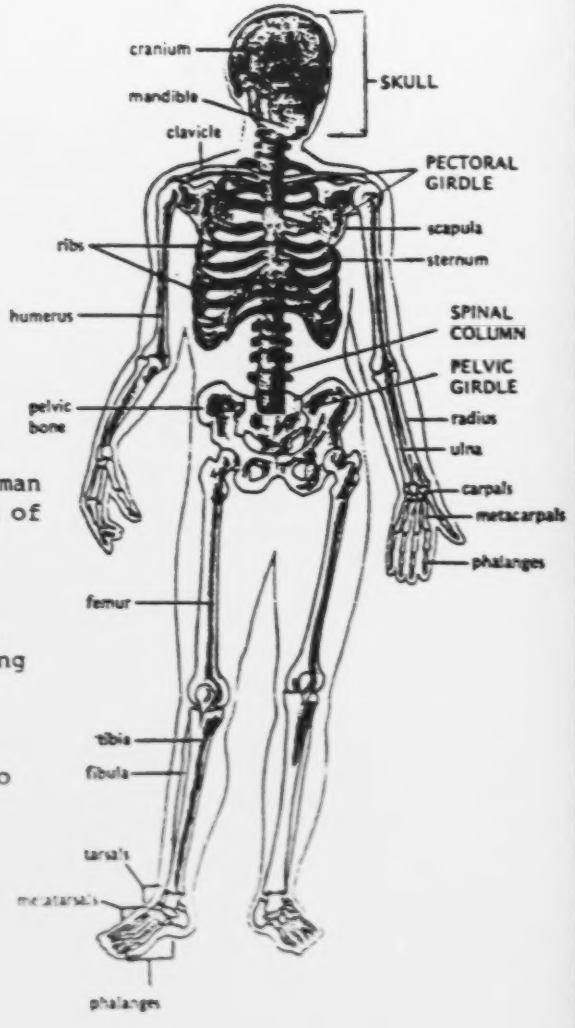


4. [D,L] Human locomotion -- Discuss the function of a human's big toe in walking. Discuss newspaper articles on jogging and its effects on the human skeleton. Use a human articulated skeleton to discuss the role of a system of bones used as levers.

5. [D,L] Sea anemone--locomotion -- Some pet stores stock sea anemone and, although somewhat difficult to maintain, they will probably remain alive long enough to demonstrate tentacle movement and feeding habits.

6. [D,L] Setae of earthworm -- Setae of an earthworm are readily visible to students using a simple hand lens.





Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Model Lesson Plan: Nutrition

Aim: How do heterotrophs obtain and process food?

Performance Objectives: Students will be able to:

- distinguish between ingestion, digestion, and egestion.
- trace the path of nutrients in representative organisms (fungi, protozoa, hydra, earthworm, grasshopper, man). [Detailed story of human adaptations are included in Unit III.]
- compare the basic structural components of digestive systems.

Motivation: Pass unsalted crackers out to each student. Ask them to chew and record the results obtained when food is partially processed in the mouth. Elicit the concept of food processing through mechanical and chemical digestion. Demonstrate using saliva or diastase, the process of digestion (chemical) using two test tubes with Benedict's solution. Elicit from students the purpose of digesting starch into smaller glucose molecules.

Concepts: Food is the source of energy. In order to use food, cells should have it processed into molecules small enough to pass through cell membranes, i.e., to be absorbed and transported. This processing includes ingestion and digestion (chemical and physical) and egestion.

Heterotrophs must get usable food from other sources.

Development

1. Provide students with outlines of the body plan of the representative organisms. Demonstrate ingestion through the use of live or preserved specimens of representative organisms.

2. Live protozoa, plus hydra, can be demonstrated using a microprojector. A live earthworm can be viewed on a screen or chalkboard by placing food, a little water, and an earthworm in a Petri dish placed on an overhead projector. A preserved grasshopper can be visually inspected in a jar carried around in class by a student.

3. Prepared models can be referred to as students are assigned the task of tracing the path of food through the cell or food tubes of higher organisms.

4. Students should be asked to compare the systems of the organisms and list the different ways that food is ingested, digested and egested. Use a chart comparing the evolutionary patterns of change from intra- to extracellular digestion.

5. For each organism, the specific structure related to the function of (a) ingestion (b) chemical and physical digestion, and (c) egestion should be listed.

6. Comparisons of structures found in these representatives should trace evolutionary patterns of change.

APPLICATION

Display a diagram of the digestive system of a fish or other vertebrate. Ask students to compare this digestive system to man, earthworm, grasshopper, hydra, and paramecium. Determine the similarity of vertebrate systems of nutrition. Ask students to compare the systems in birds or reptiles, using body plan diagrams provided on separate sheets.

Unit III: Human Physiology

Suggested time: 15 to 22 days

Unit Theme: This unit is devoted to a review of various metabolic processes in humans. The topics selected--nutrition, transport, respiration, excretion, regulation, and locomotion--apply what students have learned in the previous units in terms of life functions, and includes discussion of the body's need for appropriate nutrition, exercise, and sleep.

Each of the extended units on human physiology concentrates on direct application of previous and current learnings. For instance the human physiology extension, within the topic of nutrition, is in part devoted to selection of food substances for establishing a balanced diet.

The biochemistry extension should be more teachable than the previous syllabus because discussion ensues in a manner directly related to the preceding content. To illustrate this, hydrolysis is discussed as a required topic, followed by an extended unit describing the biochemistry and structural formulae related to the process. Students will appreciate human physiology extensions concerned with various malfunctions of physiological systems. In addition, contemporary topics such as organ transplants will serve to provide topics of current interest.

Topic 1: *Basic Anatomy and Physics of Human Digestion System*

Topic Theme: Emphasis is placed on developing understanding of the relationship of the role of digestive organs to the process of obtaining and utilizing nutrients.

Both the mechanical and chemical breakdown of food is explained as is the process of absorption and utilization of nutrients.

The topic concludes with a discussion of a number of malfunctions of the digestive system.

Teaching Strategies: *An Overview*

Most schools possess many different kinds of models, charts and visual aids for this unit. Continuous exposure to these visuals permits students to memorize structures quickly and relate functions. Students should be encouraged to share their feelings regarding health foods and exercise in order to personalize or motivate the unit. Teachers will find far more demonstrations are provided in this teachers supplement than could possibly be done in the time provided, and this pattern will be noted throughout the syllabus supplement; the teacher is advised to select as many demonstrations for each concept as can be provided in reasonable teaching time. In addition, the library lessons suggested throughout this unit will be time well spent, as these skills will be useful in developing research projects and term papers.

Teaching Strategies: *Sequential*

1. Students can list various foods eaten throughout the day and relate them to a balanced diet. Compare food labels and ingredients, and direct students to develop a balanced diet.

2. Conduct food tests with starch, sugar, fats, proteins and vitamin C. Conduct an open ended lab where students identify unknown substances for nutrient content.

3. Display charts and models of the human digestive system. Ask students to trace the path of food through the system. Conduct a food test on a chewed food substance. Relate tooth structure to the kinds of food eaten by different animals.

4. Continue discussion on the digestive system by demonstrating the peristaltic action of the esophagus. Conduct a demonstration on the effects of gastric juice on food digestion.

5. Review peristaltic actions and relate process to movement of food through the small intestine. Display model of villis. Demonstrate effect of intestinal enzymes on the process of digestion.

6. Contrast mechanical and chemical digestion. Correlate building blocks with process of absorption and synthesis. Distinguish between absorption of fats, proteins and water. Draw and label a complete diagram of the villus-lacteal complex

7. (Extended) Review the process of hydrolysis and dehydration synthesis. Using structural formulas show how glucose may be stored as glycogen and amino acids as proteins. Distinguish between complete and incomplete protein food substances.

8. Complete the process of digestion by reviewing the structures in the alimentary canal. Ask your students to explain what happens to undigested food. The role of bacteria and the process of reabsorption in the large intestine should be emphasized.

9. (Extended) Hydrolysis and dehydration synthesis have been discussed in terms of the end products of digestion and final storage. Utilize what your students have been taught to allow them to recognize the same process using structural formulas. It is most helpful to include the name of the compound immediately beneath the structured formula (as pictured in the syllabus). Use ball and stick models to re-emphasize the process.

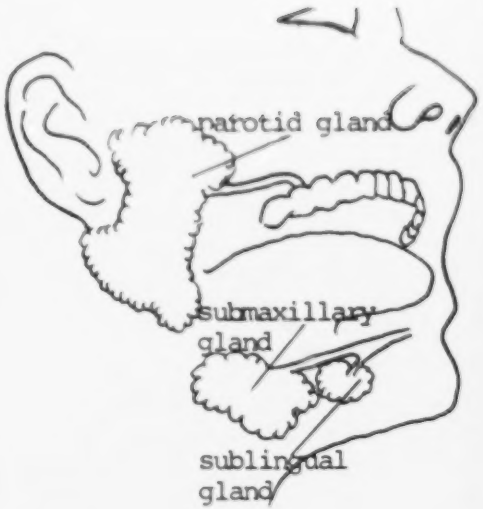
10. (Extended) Display samples of saturated and unsaturated fat products. Read a news release from the Heart Association relating accumulation of cholesterol to heart disease. Review the function of fats in the body and describe how fat tissue accumulates. Apply to a regimen of exercise and diet for controlling body weight.

11. (Extended) Utilize student reports to <u>outline</u> symptoms and treatment of diseases listed in the syllabus. Display commonly used over-the-counter medicines such as Kaopectate or Milk of Magnesia to provide health lessons.

Performance Objectives

Students will be able to

. list the structures found in the oral cavity and state a function of each.
. relate tooth structure with types of foods eaten by animals.
. explain the process of chemical digestion in the mouth.
. (extended) discuss the role of carbohydrates in human nutrition and explain the function of roughage.
. describe the process by which food passes through the esophagus.
. explain how digestion of proteins occurs in the stomach.
. identify the contents of gastric juice.



Activities

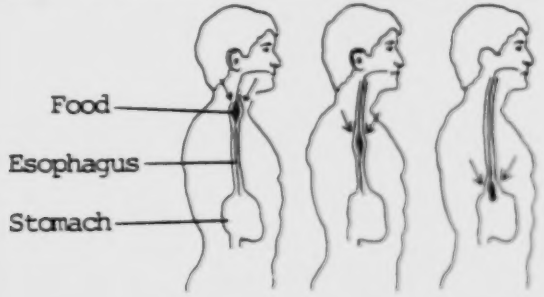
1. [D] Oral cavity -- Display a variety of animal and human skulls. Ask your students to list similarities and differences in each and to relate these factors to the type of food eaten by these animals. For instance, herbivores will exhibit well developed molars, while carnivores will display sharp long canines. What evidence exists that man is an omnivore?

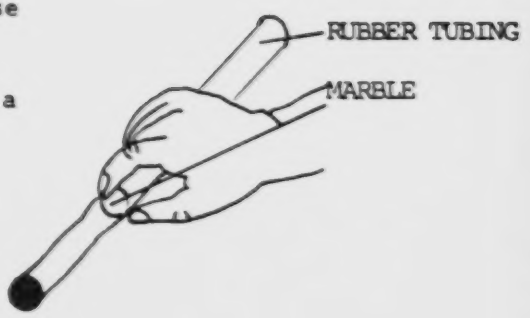
2. [D,L] Effect of saliva on food digestion -- Test an unchewed cracker for the presence of starch and sugar. (Lugol's solution turns blue-black in the presence of starch; Benedict's solution heated will turn a brick-red color in the presence of sugar.) Test saliva for both nutrients. Be sure that the student has thoroughly rinsed his/her mouth with water. Saliva may be obtained by asking a student to chew on a rubberband for a number of minutes and depositing the saliva in a test tube. Have the same student chew on the same cracker previously tested for the nutrients. Students should conclude that chemical digestion of carbohydrates occurs in the mouth.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

3. [D] Dialysis membrane starch digestion -- Add a mixture of saliva to a thinly diluted starch suspension. Place in dialyzing membrane which is suspended in water, test the water for starch and sugar at the outset of the experiment. Repeat the following day. Compare results. Why was the glucose able to diffuse through the membrane but the starch was not?

4. [D] Rubber tubing and esophagus -- Have a student move a marble through a piece of rubber tubing. Students will observe alternate contraction and expansion similar to smooth muscle movement in the esophagus.





5. [D] Swallowing upside down -- Ask an athletically inclined student to stand on his head while chewing and swallowing a cracker. Students should recognize that the process of swallowing does not depend on gravity.

6. [D] Cow stomach -- Obtain the stomach of a freshly killed animal. Chop a portion of the mucosa and place it into a .4 percent HCl solution. Stir until the mucosa is dissolved. Allow the mixture to remain in the flask for two to three days. Filter the mixture and place samples of food products into the filtrate. Students observe and record what food products are affected by the mixture.

7. [D] Test tube gastric juice -- Prepare a series of test tubes as follows: water, hydrochloric acid, pepsin, renin, and one with all (gastric juice). Place sliced egg white in each and observe over the next two to three days. Add a 1 percent NaOH solution to a new batch of gastric juice and observe the effect on digestion. Students should explain the phenomena related to the taking of antacids such as Rolaids.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Performance Objectives

Students will be able to

- describe the morphological features of the intestine and provide a function for each.
- relate the function of the gallbladder and pancreas to the process of digestion.
- state the function of bile.
- recall that final chemical digestion of carbohydrates, lipids and proteins occurs in the small intestines.
- discuss the absorption of nutrients from the small intestines.
- (Extended) summarize the basic compounds of a balanced diet and defend inclusion of each nutrient source in a balanced diet.

Activities

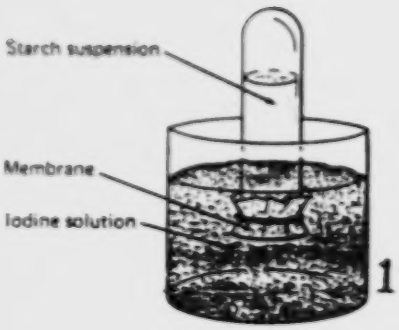
8. [D,L] Digestive system -- Label a diagram of the digestive system.

9. [D] Alimentary canal -- Display a mannequin, model or plaque of the digestive system. Identify structures. Trace alimentary canal pathway.

Dangerous Vapors

10. [D,L] Diffusion of molecules through a membrane -- Demonstrate the diffusion of molecules of ammonium hydroxide through a membrane using the setup described below:

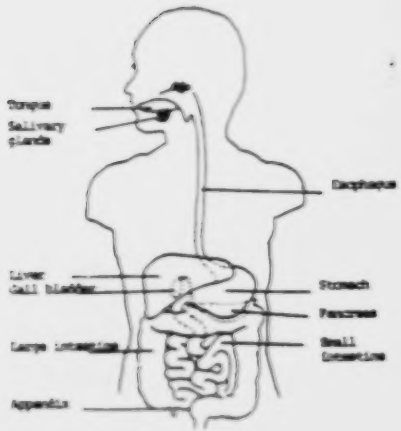
a. Add three to four drops of alcoholic phenolphthalein to a test tube three-quarters full of water. Cover with dialysis membrane (secure with rubber band).
b. Invert test tube over mouth of test tube containing ammonium hydroxide. Note and explain observations.
[Note: Moisten the dialysis membrane before using. Secure test tube to ringstands with appropriate test tube clamps.]



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

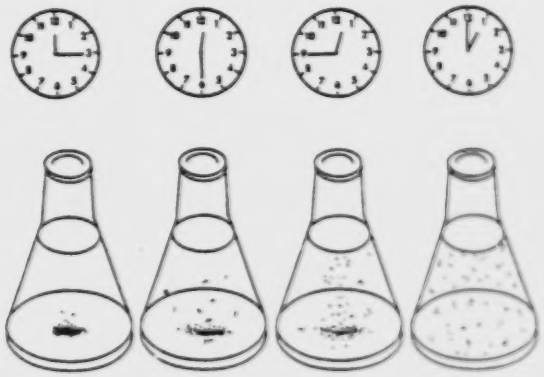
11. [D] Digestive system -- Display chart, model, mannequin of digestive system of different animals. Compare and record similarities and differences.



12. [D] Villus -- Label a cross section of the villus.

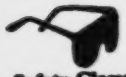
13. [D] Diffusion of potassium permanganate in water -- Place a few crystals of potassium permanganate into a beaker of water. Diffusion of molecules and eventual equilibrium state will be detected by observing the pattern of spread of the purple color.

14. [D] Diffusion of iodine crystals into starch solution -- Iodine crystals will diffuse into starch solution (1 percent) in a fashion similar to that of ammonium hydroxide-phenolphthalein setup previously described. Note: Starch solution is inverted on open-mouth test tube of Lugol's solution.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

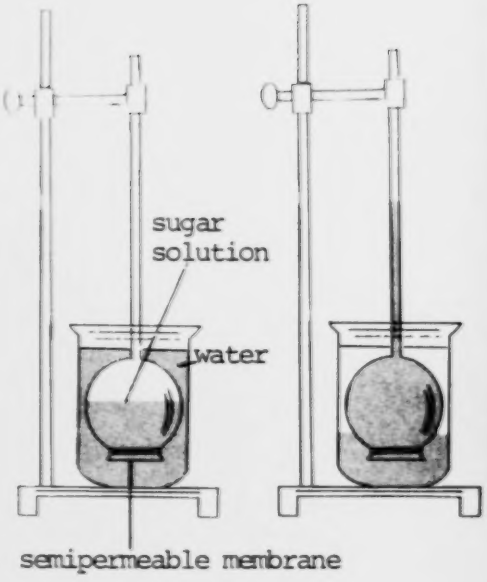
Activities (continued)


Safety Glasses

Fire

15. [D,L] Benedict's solution diffused through membrane -- Test for presence of glucose diffusion from dialysis membrane filled with solution tied off at both ends and placed in beaker of water with Benedict's solution. Heat benedict's solution and note results.

16. [D,L] Thistle tube molasses diffusion -- Demonstrate process of diffusion by placing thistle tube with molasses solution, sealed with dialysis membrane, into beaker of water.



Caustic Substance

17. [D] Decalcification of hen's egg--diffusion -- Decalcify an egg by placing the hen's egg into a beaker containing one part hydrochloric acid and two parts water for about 30 minutes. Place the decalcified egg into a dish of water covering the egg. Observe what happens to the size and shape of the egg.

18. [D,L] Food tests -- Perform laboratory tests to detect the following nutrients: starch, glucose, fat, protein, water, and vitamin C.

19. [D,L] Emulsification -- Recall experiments conducted with saliva (or amylase) and starch, gastric juice and proteins. Perform emulsification experiment placing bile mixture into cooking oil. Oil should be placed in beaker or test tube containing water. Observe and compare before and after bile treatment.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Performance Objective

Students will be able to

. describe the structure and function of the large intestines.

Activities

20. [D] Models of digestive system -- Display a mannequin, plaque or chart of the digestive system. Have students compare the structure of the small and large intestines.

21. [D] Peristalsis in the large intestines -- The very strong peristaltic action of the large intestine can be compared with the effort required to push toothpaste through a nearly emptied toothpaste tube.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Performance Objectives

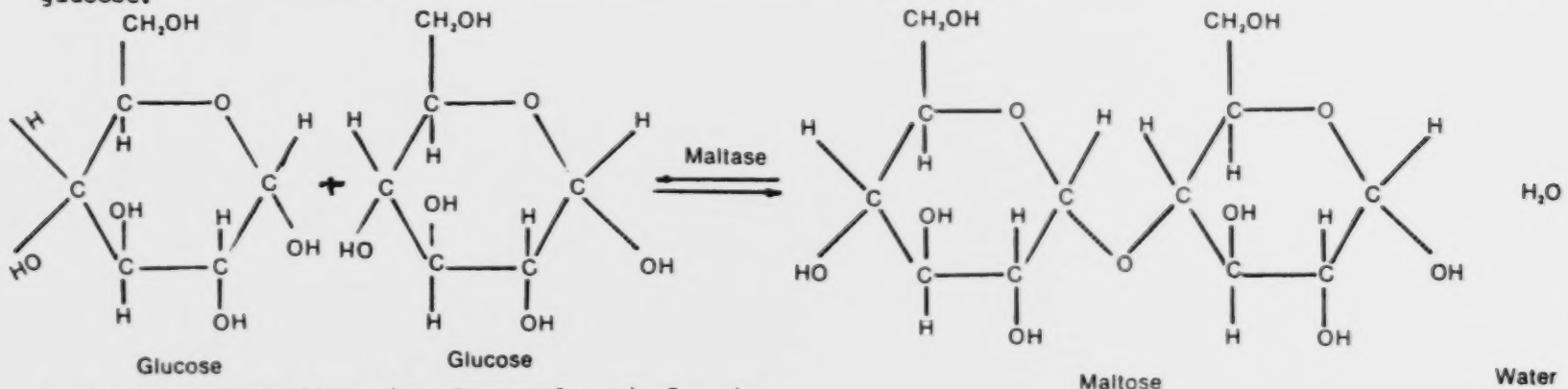
Students will be able to

- define the process of hydrolysis and describe the end products of chemical digestion.
- (Extended) recognize and identify the structural formula for hydrolysis of a carbohydrate, protein, and fat.
- distinguish between saturated and unsaturated fats.
- provide a nutritional and structural use for fats.

Activities

22. [D,L] Atoms and molecules -- Utilize ball and stick models to represent atoms and molecules of organic compounds.

23. [D] Molecular models - hydrolysis -- Prepare geometric representations (various colors and shapes) to display hydrolytic process, e.g., maltose-glucose.

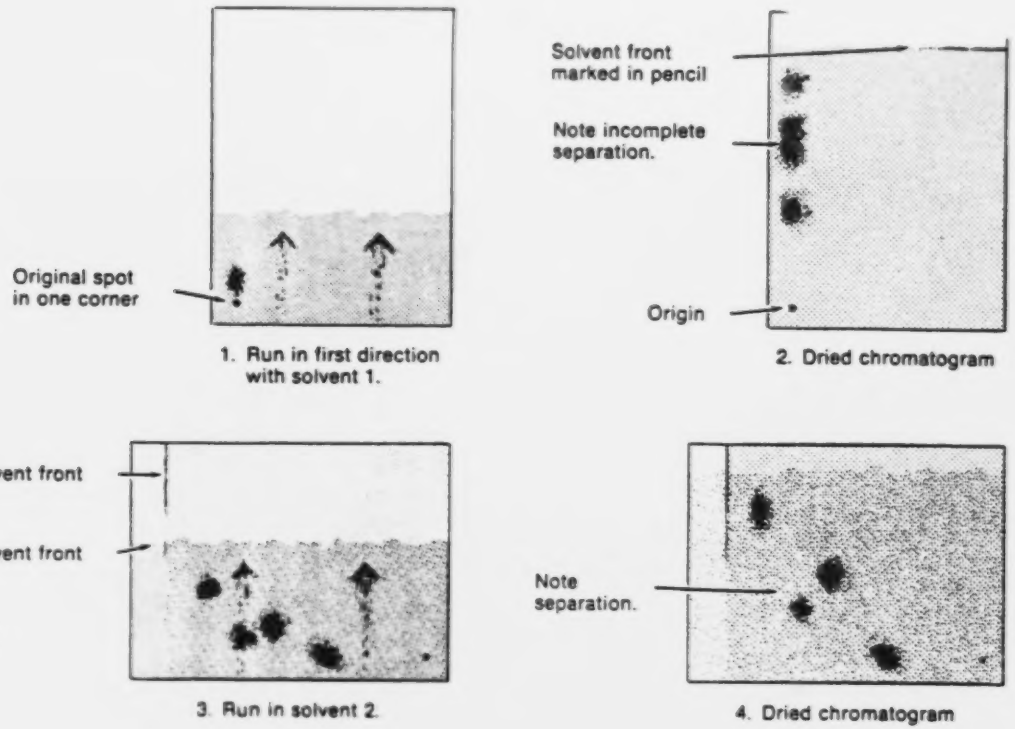


Activities (continued)

24. [D] Fats -- Display samples of saturated and unsaturated fats. Compare. Explain how saturated fats may be converted to unsaturated fats. Relate the nutritional considerations, e.g., high cholesterol.

25. [D,L] Chromatogram of amino acids -- Display chromatogram of two different proteins, e.g., egg white albumin, blood. Analyze pharmacology values in terms of amino acid composition. Relate to process of digestion.

CHROMATOGRAPHY



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Performance Objectives

Students will be able to

. describe the symptoms and treatment of
    . ulcers
    . constipation
    . diarrhea
    . appendicitis
    . gallstones
. evaluate and compare types of treatment for each disease.

Activities

26. [D] Obstruction of bile duct -- Display a model, plaque or chart of the digestive system. Place a marker to represent an obstruction in the bile duct. Ask students to predict the symptoms related to this condition. Similar representations may be made for each disease listed in this section.

27. [D] Student reports (library lesson to precede this activity) -- Either by row or by committee identify each disease, and state causes, symptoms, and treatment.

28. [D] Individual experiences (use discretion) -- Have students give experiences, either personal or those related to friends or relatives.

29. [D] Over-the-counter medications -- Display Rolaids, Milk of Magnesia, and Kaopectate. Relate pharmacology to treatment of disease.

Key: D - demonstration, L - laboratory lesson, R - report, S - speaker, P - project

Activities (continued)

30. [D] Ingestion and digestion -- Students observe peers chewing and swallowing a cracker. Conduct sugar (Benedict's solution) test on unchewed cracker and then on cracker that has been chewed for about two minutes. Class should be able to distinguish between ingestion and digestion and between physical and chemical digestion.

31. [D] Mechanical digestion -- The need for mechanical digestion may be demonstrated by placing coarse pieces of egg and finely chopped egg white into test tubes containing gastric juice. Observe for two to three days.

32. [D] Starch test -- Add diastase to a starch solution that has been tested with Lugol's solution and thus will appear blue-black. How long does it take for the blue-black color to fade? Can the rate be increased by heating the solution.?

33. [D,L] Protozoan digestion -- Demonstrate ingestion of carmine-red particles in paramecium or amoeba. The red-stained vacuoles become very obvious.

34. [D,L] Alimentary canal -- Have students compare the alimentary canal of the grasshopper, earthworm, and man. Similarities and differences should be noted.

35. [D,L] Frog dissection -- Display a dissected frog to show the beating heart and circulatory system network. [Note: Be sure frog is properly pithed or anaesthesized.]

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 2: *Transport*

Pages 54 to 59

Suggested time: 3 to 4 days

Topic Theme: This topic concerns itself with the components of the circulatory system including the pathways of circulation and body fluids as well as the function for each.

The maintenance of homeostatic equilibrium, and immunity defense mechanisms are discussed. Blood composition and characteristics are applied in the teaching of blood clotting and cross-matching blood transfusions.

The structure of the cardiovascular system is related to pulmonary, systematic, coronary and lymphatic circulation. Cardiovascular and blood disease refer to the most frequently occurring "malfunctions" of the transport system.

Current topics include organ transplants and immunization. The teacher will want to expand both of these topics to reflect contemporary technology such as the use of an artificial heart. Autoimmune diseases are not directly discussed, however. Their inclusion would serve to further update this topic.

The delivery of nutrients and oxygen, removal of metabolic wastes, maintenance of proper pH and water balance are all related to homeostatic balance achieved by this system.

Teaching Strategies: *An Overview*

Organ transplants, heart lung machines, and cardiovascular diseases are daily occurrences in the news media. Displaying a picture or reviewing a newspaper report about Dr. Barney Clark will serve to motivate this unit.

Relate the need for the end product of digestion to be transported to each cell in our body. Students may suggest a system of tubes and pumps that will accomplish this task.

Once more, models and charts should be generously used throughout.

Teaching Strategies: *Sequential*

1. Review the advantages and disadvantages of unicellularity versus multicellularity. Students should recognize the need to transport material to and from each cell in multicellular organisms, a situation in which most of the organisms or cells are not in direct contact with the environment. Display charts of circulatory system, expired blood, fractionated blood.

2. (Extended) Retell an episode involving a hemophiliac. Demonstrate and time blood clotting by use of capillary tubing. Review process of clotting using flow chart. Emphasize biofeedback mechanisms.

3. Distribute several articles dealing with the acquired immune deficiency disease (AIDS). Why is the disease almost always fatal? Display a chart or drawing representing different kinds of white blood cells. Differentiate between phagocytes and lymphocytes. Discuss role of each in the process of immunity.

4. (Extended) Survey the class and record numbers of students who have been vaccinated against a variety of diseases. Define immunity. Why is it unlikely that an individual who recovers from chicken pox will ever get the disease a second time, even though he may be exposed to the organism. Distinguish between active and passive immunity. Repeat survey exercise to determine type of allergies experienced by students. Geometric projections and magnetic discs can be used to demonstrate antibody-antigen complex.

5. (Extended) Distribute blood lab permission slips before class. Retell the story of large numbers of casualties during the Civil War who were given transfusions of incompatible blood. Demonstrate blood typing using test serums (A, B, O, and Rh). Apply understanding to organ transplants.

6. Recall the process of diffusion by comparing movements of molecules through a moist and dry membrane. Relate this need with the presentation of intracellular fluids and lymph fluids. How does this fluid return to general circulation? How are waste products and other substances (hormones) removed from cells and replenished with needed nutrients and respiratory gases. Display different sizes of tubing of varied width and flexibility. Students select tubing that most represents arteries, veins, capillaries and lymph vessels. Hook up an aquarium tank pump. Relate to the need of a pumping mechanism (heart) for transporting the fluids. Note the difference between an aquarium pump and the heart.

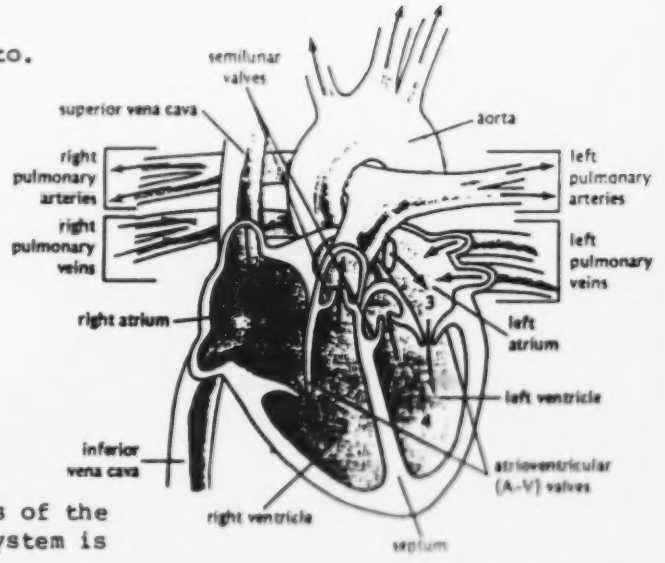
7. (Extended) Display model and chart of heart. Students should explain the value of a four-chambered heart. A chart of general circulation will allow students to distinguish between pulmonary, systematic, coronary and lymphatic circulation.

8. (Extended) Utilize student reports and guest speakers. Discuss symptoms, treatment and prognosis of cardiovascular diseases and blood conditions listed in the syllabus.

Performance Objectives

Students will be able to

- describe the components of blood and state a function for each.
- (Extended) outline the process of clotting.
- (Extended) discuss the phenomena of immunity.
- (Extended) distinguish between active and passive immunity.
- (Extended) list a number of substances that people are allergic to.
- (Extended) explain blood-typing and transfusion.
- (Extended) outline the problems involved in organ transplants.
- distinguish between intracellular fluids and lymph.
- conduct an experiment to type blood.



Activities

1. [D] Models and charts -- Display models of the heart and charts of the circulatory system. Ask students to explain why they think this system is named the circulatory system.

2. [D] Expired blood -- Obtain "expired" blood from a hospital or blood bank. Review with your students the cross-matching identification placed on the blood container. Ask officals at blood-bank if blood has been screened for, or if donor has been screened for, AIDS contamination.

3. [D] Blood centrifuge -- Centrifuge a portion of the blood and analyze its components.

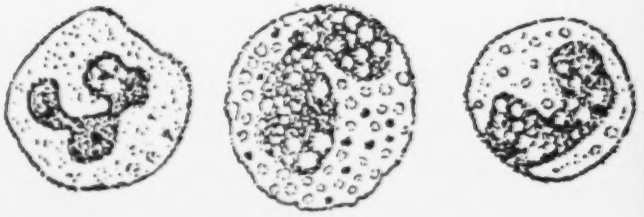
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

4. [D,L,P] Microscope slide - blood -- Place a drop of blood about an inch from the end of a clean glass slide. Hold a second slide at an angle of 30° so that one end touches the drop of blood; the second slide will serve as a spreader pulling a thin film of blood across the bottom slide. Let the film of blood dry in the air.

Human red blood cells

Human white blood cells (leukocytes).



5. [D,L,P] Wright's stain -- Wright's stain may be used to stain the blood film for greater detail.

6. [D,L,P] Permanent slides -- Permanent slides may be made by using a mounting media such as Canada balsam.

Breakage

7. [D,L] Blood clotting -- Draw a quantity of blood through a capillary tube. Time the clotting process. Ask students to record their observations and explain its biological value.

8. [D] Anticoagulant activity -- Sodium citrate, a common anticoagulant, may be added in various concentrations to blood. Test the effects of this substance on the clotting time of the blood.

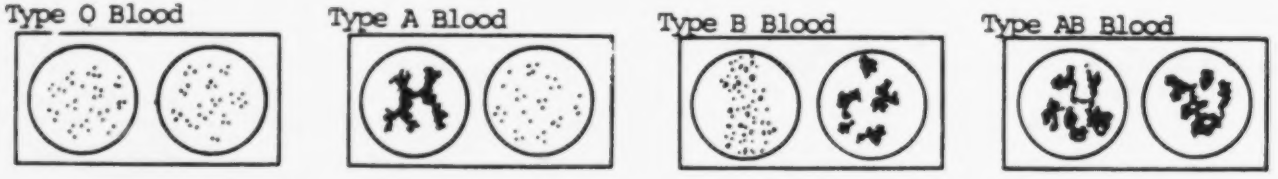
9. [D] Blood clotting and coagulation -- In a clean test tube, mix two types of blood (A and B). After a period of time observe for evidence of clotting. Students should deduce observation at outset, and provide hypothesis for results. Add sodium citrate to the clot. Observe what occurs.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

10. [D,L] Blood typing lab -- Students complete parental consent slip and conduct blood typing experiment utilizing antityping serums A, B and Rh.

a. Display chart on blood tissue composition.
b. Students may request their family to provide blood for blood typing or simply ask them for their blood type. Work out heredity considerations.



11. [D] Allergy antibody -- Display a variety of allergy pills (Contact, Dristan). Students should read carefully the instructions provided with each carton and list the symptoms that are treated by the medication.

12. [R] Library research -- Students should research and report to the class on organ transplants.

13. [R] AIDS -- Newspaper and magazine articles can be discussed as related to AIDS and other autoimmune diseases.

14. [R] Allergies -- Students can discuss specific allergies they may have and symptoms and treatment of each.

Key: **D** = demonstration, **L** = laboratory lesson, **R** = report, **S** = speaker, **P** = project

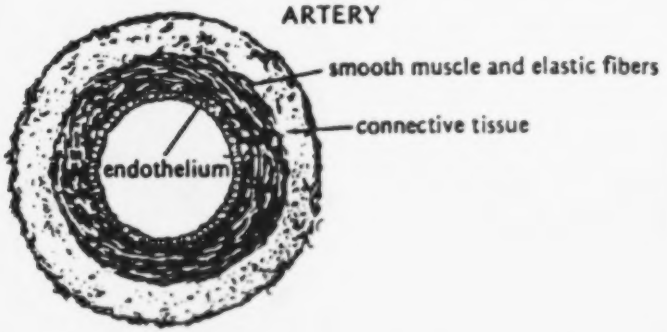
Performance Objectives

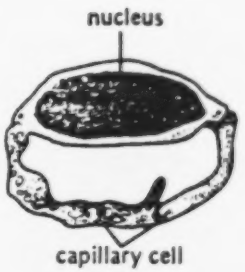
Students will be able to

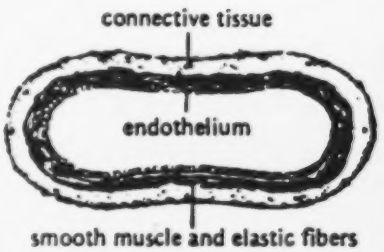
- describe and diagram arteries, capillaries and veins.
- compare structure and function of transport vessels, arteries, capillaries, veins, lymph vessels.

Activities

15. [D] Circulatory system--microscope slides -- Display prepared microslides of arteries, veins and capillaries. Students should diagram, label, and explain adaptation of each.







16. [D] Model: arteries, capillaries, veins -- Use tubing of various diameters and thicknesses and relate to arteries, veins, and capillaries.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Performance Objectives

Students will be able to

- describe the human heart and state a function for each part.
- (Extended) trace the path of blood through the heart.
- (Extended) compare and describe pulmonary, coronary and lymphatic systems.
- (Extended) review symptoms and treatment of high blood pressure and heart attack.
- (Extended) distinguish between anemia and leukemia.
- evaluate various types of treatment for each cardiovascular disease.

Activities

17. [D] Blood circulation in goldfish -- Observe blood circulation in a goldfish tail. Place a goldfish in a Petri dish. Cover the tail with a glass slide and examine under low and high power. Wrap a piece of cotton around the goldfish. Keep the cotton moist.

18. [D] Alternative demonstration to No. 17: Observe circulation in tadpole tail and web of frog's foot.

19. [S] Guest speaker -- Heart Association speaker to discuss heart disease and related illness.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

20. [R] Literature available -- Obtain brochures (available in class quantity) from the Heart Association. Complete listing of brochures, pamphlets, charts, and other related items are available on request.

21. [R] Research -- Either individually or by committee study each of the following: high blood pressure, coronary thrombosis, angina pectoris, anemia, leukemia. Plan oral reports and/or research papers with references.

22. [R] Models, charts -- Appropriate models, charts, and other visuals to display the morphology of heart disease.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 3: *Respiration*

Pages 59 to 62

Suggested time: 2 to 3 days

Topic Theme: Students are taught the structure and function of each part of the respiratory system as air passes through. Distinction is made between external and internal respiration with reference to aerobic and anaerobic respiration. Key concept in topic should be to refer to respiration as a process that provides energy for all metabolic processes. As with previous topics in this unit, a number of malfunctions or disease conditions are discussed.

Teaching Strategies: *An Overview*

Ask your students to differentiate between respiration and breathing. Plan in advance to obtain a haslet from a freshly killed animal. Most butchers will oblige if given enough notice. Students tend to gain a much better appreciation for the structures involved when viewing animal organs rather than models.

Teaching Strategies: *Sequential*

1. Review differences between cellular respiration and oxidation. Burn a butter candle or marshmallow. Extinguish a candle by placing it in a jar that is sealed after the candle is lighted. Distinguish between breathing and cellular respiration. Display mannequin, bell jar, and chart of respiratory system; trace path of air through nasal cavity, pharynx, trachea. Elicit need for rigid cartilage-supported trachea.

2. Ask students to explain what can cause sinusitis. Display model and charts of the respiratory system. Continue to discuss the pathway of air through the system.

3. Display bell jar model. Ask students to relate model to structures identified in human breathing system. Allow them to observe inflation and deflation of balloons when rubber sheet is moved up and down. Display rebreather (may be available from the health department). Alternative paper bags are sometimes used to have hyperventilated patients rebreath their air, thus increasing CO_2 concentrations. Significance of the CO_2 feedback mechanism for maintaining homeostasis is a key concept.

4. (Extended) Using student reports or other activities suggested, review symptoms, treatment and prognosis of conditions listed in syllabus.

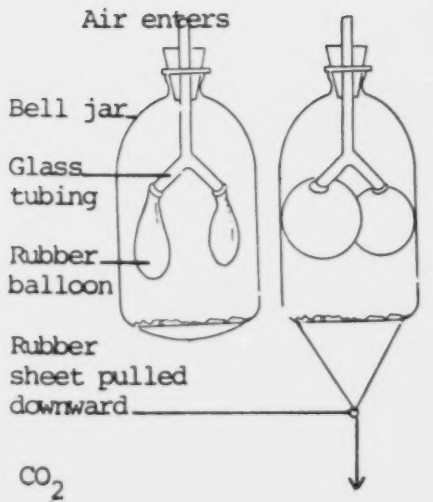
Performance Objectives

Students will be able to

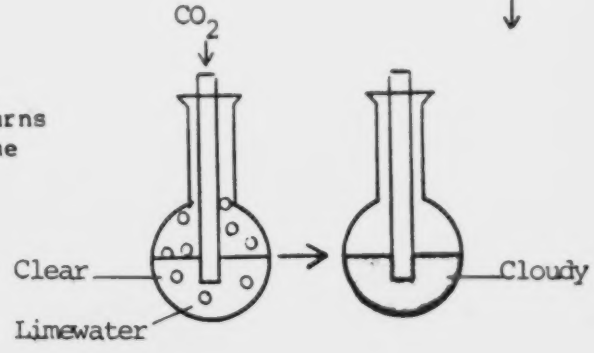
. state the functions of the respiratory system.
. distinguish between external and cellular respiration.
. trace the path of air through the respiratory system.
. list the parts of the respiratory system and provide a function for each.
. discuss the process of breathing.
. explain how the breathing rate is controlled.

Activities

1. [D] Bell jar apparatus -- Display the bell jar apparatus. Have students compare the demonstration with a model or chart of the human respiratory system.



2. [D] Limewater CO_2 Reaction -- Students exhale into clear limewater (turns milky white in the presence of CO_2) or into brom-thymol blue (turns yellow in the presence of CO_2). Use control, e.g., inhale from the same solution in another container as in illustration.

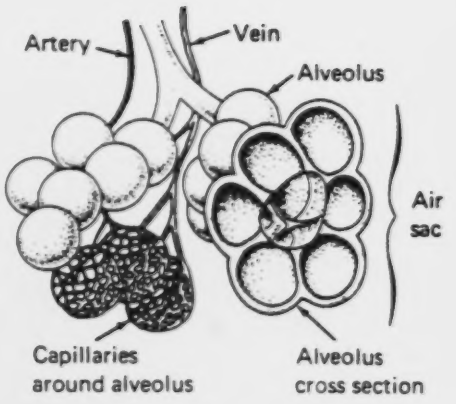


Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

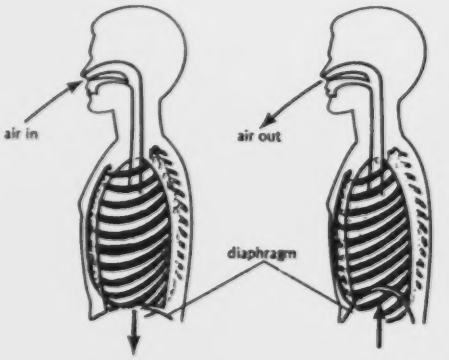
3. [D] Animal organs - thoracic section -- Obtain thoracic sections (lungs, bronchial, and trachial tubes) of pig, cow, or sheep from a slaughterhouse or butcher. Then dissect bronchial tube and lungs. Place aquarium airpump hosing in bronchial tube to demonstrate lung capacity. Examine microscopic cross sections for examination of alveoli.

4. [D] Model Alveoli -- A Florence flask may be used to represent an air-sac alveolus. Use a glass marking pencil to represent capillary network, with red for arterioles and blue for venules. Capillary alternative: glue- colored threads (blue and red) on the outside of Florence flask represent capillary network.



5. [D] Spirometer -- Lung capacity is measured with a spirometer. Use a laboratory model that requires a student to exhale into a gallon jug inverted into an aquarium. Measure the amount of water required to refill the container. Compare extrapolated lung capacity with other students in the class. How does lung capacity relate to sex, age, size, athletic ability?

6. [D,L] Rate of breathing -- Count and compare the rate of breathing before and after 30 seconds of a controlled exercise routine, e.g., deep knee bends. Relate age, sex, and history of exercise or athletics to differences in rate of breathing.



7. [R] Reports -- Research breathing mechanisms in other living things, such as gills of tadpoles, lungs of frogs, book lungs of spiders or horseshoe crabs, tracheae of insects.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Performance Objectives

Students will be able to

- give the symptoms of bronchitis, asthma, and emphysema and the causes for each disease.
- discuss the treatment for and/or prevention of each disease studied

Activities

8. [D,L] Heimlich's maneuver -- Demonstrate Heimlich's maneuver for assisting a choking victim. Students should explain how and why the maneuver works.

9. [D,L] Artificial respiration -- Demonstrate artificial respiration, and mouth-to-mouth resuscitation. (Where possible utilize a resuscitation model available in most health departments.) Students must explain mechanics of each procedure.

10. [S] Speaker -- Invite a guest speaker from the American Lung Association. In most instances they are capable of addressing a wide range of topics including therapy, treatment for disease, and causes.

11. [R] Reports -- Research diseases identified in the Regents biology 1982 syllabus. Individual or committee reports may be used for reference.

Key: D - demonstration, L - laboratory lesson, R - report, S - speaker, P - project

Activities (continued)

12. [R,S] American Cancer Association -- The American Cancer Association provides posters and pamphlets related to the hazards of smoking. A guest speaker can be obtained from them.

13. [R] Environmental Protection Agency -- This agency provides data regarding air quality and air pollution. Students can relate this data to the incidences of lung disease.

14. [R] School survey -- Have your students survey the community and list conditions leading to air pollution.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 4: *Excretion*

Suggested time: 2 to 3 days

Topic Theme: Students will learn the structure and function of the various parts of the human excretory system. Then follow the path of fluids through the urogenital system and discuss the removal of nitrogenous wastes and other waste products by the process of filtration and reabsorption. Other excretory organs, the lungs, liver, and skin are reviewed in terms of their role in excretion. Excretory waste products are listed, their origin investigated and organs for removing them from the system disclosed.

Teaching Strategies: *An Overview*

The use of dialysis machines and kidney transplants has become a daily occurrence. The Kidney Foundation will provide literature that may be distributed in advance. Students can report to the class about kidney disease and the various treatments. Dissection of sheep kidney is particularly effective in this unit.

Be sure to distinguish between excretory, (metabolic, wastes) and egested-solid waste material). Carry through the listing of metabolic wastes as you discuss each organ system.

Teaching Strategies: *Sequential*

1. By analogy, describe the need for the end products of combustion to be removed from an automobile. Ask students to list those metabolic products that cannot be used efficiently by the body, or whose accumulation would be toxic. Display lung, liver, and skin cross sections. For each organ identify major structures and label waste products removed. Sweat gland mechanisms can also be related to maintenance of body temperature.

2. Distribute articles or pamphlets from the Kidney Foundation identifying the nature and degree of kidney disease - the use of dialysis and kidney transplants. Display and dissect a sheep kidney. Trace the path of urine production, storage and removal.

3. Through the use of student reports and/or guest speakers from the Kidney Foundation, review some of the diseases associated with kidney malfunction, and a nonkidney but the urea-associated disease, gout.

Performance Objectives

Students will be able to

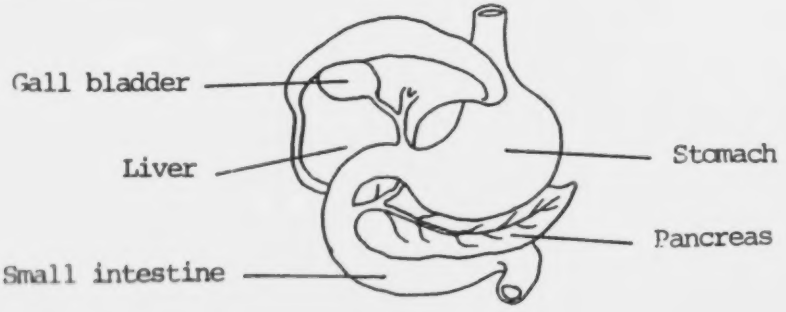
. identify the waste products removed by the lungs during the process of exhalation.

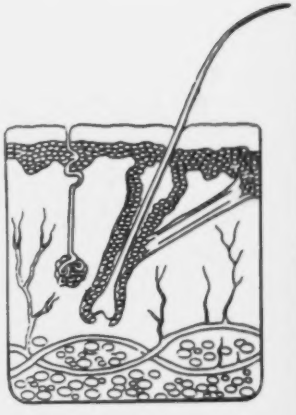
Activities

1. [D] Sheep/cow lung -- Dissect a sheep or cow lung. Some butchers will supply them for you at a moderate cost. They are excellent for classroom experiment.

2. [D,L] Limewater/brom-thymol blue -- Repeat experiments discussed in respiration section involving students exhaling into solution of limewater or brom-thymol blue.

3. [D] Models, mannequin, chart, lungs, kidneys, skin cross section, liver (digestive system plaque).





Skin Cross Section

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Performance Objectives

Students will be able to

. describe the process of deamination.
. describe the structure and function of the liver as it relates to excretion.

Activities

4. [D,L] Liver specimen -- Obtain specimens of chicken livers. Students view lobes of the liver. If the liver is fresh, students will observe a network of blood sinus within the lobe by visualizing the accumulation of blood at the sinuses.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Performance Objectives

Students will be able to

- diagram a sweat gland and label each structure.
- describe the structures of the sweat gland and a function for each.
- identify and list the waste products that are removed by the sweat glands.
- relate the production of perspiration to homeostatic balance and temperature control.

Activities

5. [D,L,P] Estimating amount of perspiration produced -- Place your thumb down into a dry, loosely fitting 6 to 8 inch test tube. Allow the tube to remain on your thumb for at least 15 to 20 minutes. Measure the amount of perspiration with a graduated cylinder. Alternatives: Weigh the test tube before and after the experiment. Extrapolate from a standardized sample an X amount of water. Volume in graduated cylinder = weight of water. You can now estimate the total amount of perspiration excreted from the skin all over your body. (Assume that every part of your skin excretes an equal amount of sweat. We know this is not true.)

6. [D] Skin cross section - model or chart -- Display a model or chart of a skin cross section. In all cases it is advisable to have students diagram and label charts or models used. Freehand diagrams, although perhaps not as effective as prepared diagrams, are a better teaching tool.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

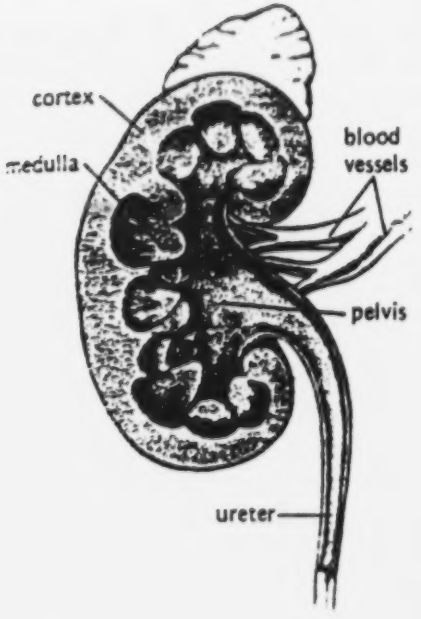
Performance Objectives

Students will be able to

. name and discuss the different types of excretory wastes removed by the kidneys.
. identify and state the parts of the excretory system (urogenital).
. describe how the kidneys help the body to maintain homeostasis.

Activities

7. [D,L] Dissection - cow/sheep kidney -- Dissecting a sheep or cow kidney, display the cross-section of the specimen and the associated collection tubules. Ask your students to suggest how the parts of the kidney are related.



8. [D] Model, chart of kidney -- Useful when used in conjunction with hand-drawn diagram and dissection.

9. [D] Model nephron -- Crumble some red string and place within a thistle tube. You now have a model of a glomerulus, Bowman's capsule and collecting tubules.

10. [D] Ornithine cycle -- Reverse the ornithine cycle by converting urea to ammonia by the action of urease. Add phenolphthalein to the mixture and note the color change as the solution becomes alkaline due to the ammonia conversion.

159

160

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

11. [D,L] Clini-Test tablets and strips -- Demonstrate the use of Clini-Test tablets and strips for the presence of sugar and proteins (albumin) in a sample of urine.

12. [D,L] Urine - Benedict's solution -- Contrast a sample of normal urine with one that has had a small amount of glucose added. Place approximately 5 cc of Benedict's solution in 8 to 10 drops of urine. Gently heat the mixture and note color change. Blue (normal) yellow-orange - deep brick red color changes corresponding to concentration of sugar.

13. [D,L] Crystallized perspiration -- Allow a sample of perspiration to crystallize on glass slide. Observe under a microscope; devise chemical tests to determine which substances are present in the perspiration.

Performance Objectives

Students will be able to

. identify symptoms, cause, and treatment of kidney disease and gout.
. prepare a written report on how the artificial kidney machine works.
. explain the problems in kidney organ transplants.

Activities

14. [D] Dialysis filter -- Display a photograph or obtain a filtering device used in a dialysis apparatus. Ask your students to suggest how the apparatus works. Discarded filters (those already used) can be obtained free of charge from dialysis units in hospitals.

15. [S] Kidney Foundation -- Guest speaker from the local Kidney Foundation to discuss kidney disease and treatment.

16. [R] Reports -- Library research and oral reports on kidney disease, dialysis, gout, and organ transplants. Assign by committee or individually. Select one topic.

17. [R] Visits -- Visit hospital dialysis facility. Students can be provided with tour and explanation of apparatus being used. Patients can be interviewed for a deeper appreciation. (Students should be cautioned to prepare questions in advance, as in any field-trip/interview situation.)

Key: **D** = demonstration, **L** = laboratory lesson, **R** = report, **S** = speaker, **P** = project

Topic 5: *Regulation*

Pages 64-69

Suggested time: 3 to 4 days

Theme: The topic begins with a comparison of the two systems concerned with the process of regulation--the nervous and endocrine systems. The approach suggested in the syllabus might best be postponed until the individual systems are discussed.

The study of the nervous system opens with a discussion of the basic unit of the system, the neuron. Structure and function of the types of neurons and parts of the central and peripheral systems are presented along with regulatory responsibilities of each. The nature of nerve impulse is inferred but not discussed in detail.

The endocrine system is presented through a listing of the glands found in this system. Specific hormones and regulatory processes are mentioned for each substance. Homeostatic balance and equilibrium mechanisms are identified throughout. As with previous topics, selected diseases or malfunctions of the two regulatory systems are identified.

Teaching Strategies: *An Overview*

By this time your students should have gained an appreciation for the precise coordination of activities within each organ system. They can be further motivated by recognizing a need to coordinate all of the systems to work together in the organism.

Students could relate the need for coordination by analogy in the discussion of the operation of an automobile or indeed any mechanical device.

Teaching Strategies: *Sequential*

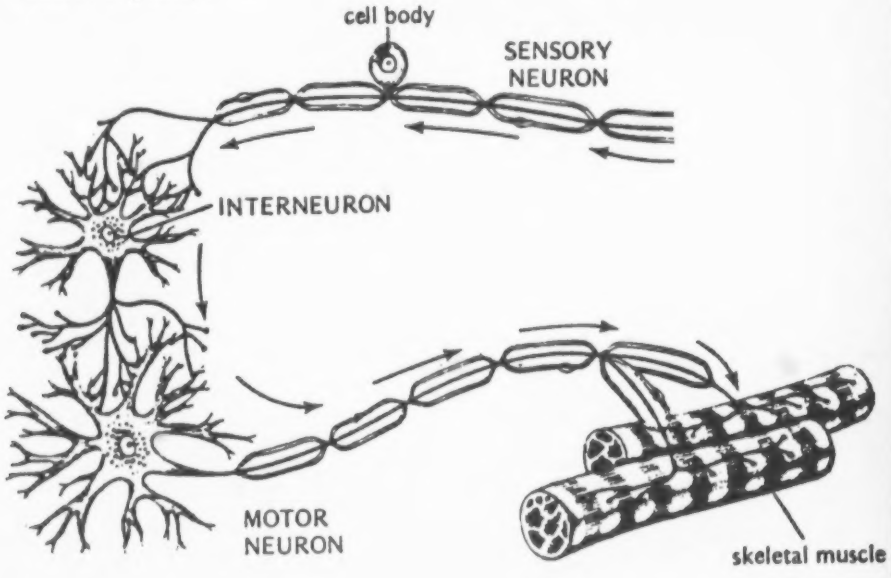
1. Provide students with several examples of situations where a coherent, well integrated regulatory mechanism is called up for the well-being of the individual (e.g., reaction to exposure to excessive heat or cold). Define function of nervous and endocrine systems and compare both in the process of regulation.

2. Display an electric circuit board and/or cross section of a telephone cable. Correlate and connect structure of wire to structure of neuron. Use diagrams. Label structure and identify function of neuron. Distinguish between sensory-motor and interneurons.

3. Compare behavior of hydra to earthworm or grasshopper. Recall differences as a function of a centralized nervous system. Utilize models, charts, preserved specimens. Identify structure and function of central nervous system.

Define a habit. Provide examples of habits. Have students explain how a habit is acquired.

4. Use demonstrations suggested for reflex arc. Record pathway. Discuss secondary effects, e.g., removing hand from source of heat, thought process (providing first aid to relieve pain).



Utilizing charts and pictures, relate the central nervous system to the peripheral nervous system.

5. (Extended) To discuss the somatic and autonomic divisions of the peripheral system, use illustrations available in most texts that display a full-front representation of a human with each system responsible for control labelled.

6. (Extended) Utilize student reports and/or guest speakers from various organizations to discuss diseases listed in syllabus. Note problems regarding the causative agent of cerebral palsy.

Performance Objectives

Students will be able to

- distinguish between sensory, motor, and interneurons.
- name the parts of a neuron and describe how each functions in the transmission of an impulse.
- list the structure and function of each part of the central nervous system.
- compare the central nervous system with the peripheral nervous system.
- discuss and contrast the somatic nervous system and autonomic nervous systems.
- summarize the symptoms of and treatment for cerebral palsy, meningitis, stroke, and poliomyelitis.

Activities

1. [D] Knee-jerk reflex -- Use the knee-jerk reflex to demonstrate nervous system control and as an introduction to the nervous system in general.

2. [D,L] Mapping sensory neurons -- Place a screen on the back of your hand. Using chalk dust form a grid approximately one square inch. Stimulate each square by gently pressing a toothpick to each point. Identify pain and pressure spots. Map these spots on a piece of paper marked off to resemble the grid on your hand. Compare, contrast, and discuss maps of different students.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

3. [D,L] Mapping sensory neurons -- Alternative exercises:

a. Spatial discrimination test: Measure the distance in millimeters when two pointed objects are held close to each other, then pulled apart until you can detect two points.

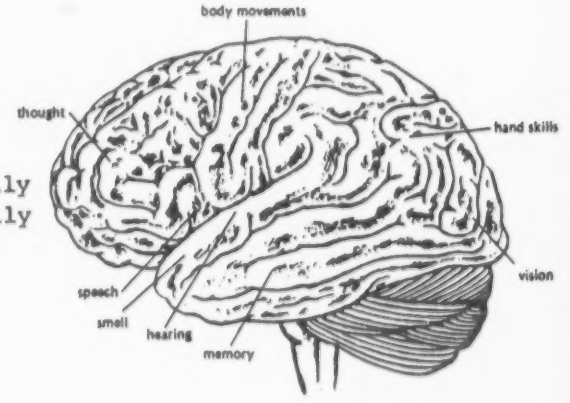
b. A fine point (not sharp) knitting needle may be placed in hot water and/or ice cube to detect presence of hot and cold receptors on skin grid.

c. Determine variation in sensitivity in some of these locations: bottom lip, sides of nose, tip of tongue, palm of hand, back of neck, arm. Students can compare results and list those areas with the greatest amount of sensitivity.

4. [D,L] Taste buds -- Taste buds can be tested by application of sugar (sweet), powdered coffee or quinine water (bitter), salt, and vinegar (sour). Students should draw and label a map of the tongue indicating areas sensitive to the flavors.

5. [D] Models, charts, plaques -- Models, charts, plaques of brain, spinal cord, nervous system.

6. [D,L] Brain dissection -- Dissection of brain and/or spinal column. A butcher may be able to request items from a slaughterhouse. Items are readily available through commercial suppliers. Dissection instructions are generally included or may be requested from supplier.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

7. [D,L] Eye dissection -- Although not discussed specifically in this section, dissection of mammalian eye (sheep's eye or cow's eye) is always of interest to students.

8. [D,L] Identifying taste -- Ask students to identify certain foods (raw apple, potato, or onion) when their nose is pinched closed. They will discover that most taste is really a combination of smell and taste.

9. [D] Comparative brain anatomy and structure -- A comparative study of brain volume (and by inference intelligence) can be made by filling the skull of a human and another animal with sand and comparing the volume. Skulls should be of comparable age.

10. [R] Reports -- Have students research symptoms and treatments presently being provided for patients suffering from diseases listed in syllabus. Individual or committee reports will develop writing, listening, and oral skills. Guest speakers from organizations, e.g., United Cerebral Palsy, will provide both a great deal of literature and insight into the various diseases.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Teaching Strategies: *Sequential*

1. Display pictures of conditions resulting from hyper- or hyposecretion of hormones (e.g., giant/dwarf). Review comparison of endocrine and nervous sytems. Locate and identify endocrine glands.

2. Retell stories of circus side shows (now disallowed in most states), e.g., giant, bearded lady, or dwarf relating these conditions to malfunctioning of hormone production.

For each gland listed, locate and identify the hormone it produces, and state the function. Include a discussion of hyper- and hyposecretion. Emphasize the role of the endocrine system in reacting to feedback and in maintaining homeostasis.

3. Utilize student reports or guest speakers to discuss cause, symptoms, treatment, and prognosis of goiter/diabetes.

Performance Objectives

Students will be able to

- explain the function of the endocrine system.
- describe how hormones are transmitted throughout the body.
- indicate the location of each endocrine gland, identify the hormones produced, state a function for each hormone, explain the affect of over-production and underproduction.
- describe the symptoms and treatment of goiter and diabetes.

Activities

11. [D] Insulin -- Display bottles of insulin (drugist often has samples of outdated supply). Ask students to explain how insulin is used in the treatment of diabetes.

12. [D] Charts and models -- Charts and models displaying location of endocrine glands.

13. [D] Pictures of endocrine abnormalities -- Pictures of medical conditions resulting from hyper- and hyposecretion of endocrine secretions.

14. [D,L] Illustration - endocrine glands -- Students are provided with a blank frontal outline of a human and are asked to illustrate the location of the endocrine glands.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

15. [D] Chart - endocrine glands -- Prepare a chart that lists each gland, its location, secretion, control, and malfunction.

16. [S] Speaker - diabetes -- Invite a diabetic to discuss how doctors discovered his or her disease and the type of treatment he or she is undergoing.

17. [S] Diabetes Association -- Contact the American Diabetes Association for pamphlets, films, other visuals, and guest speakers.

18. [R] Library research -- Librarian prepares research format lesson on topics listed previously. (This technique may be used on all research papers.)

19. [R] Oral Reports - endocrine glands -- Students report individually or in committee on various diseases being studied.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 6: *Locomotion*

Pages 69-71

Suggested time: 2 to 3 days

Topic Theme: The text explains the structure and composition of the human skeleton and integuments. Emphasis is placed on function with little reference to identifying the names of the actual bones.

The discussion of cartilage compares embryonic and adult tissue and states various functions of the connective tissue.

The three types of muscle tissue are described with reference made to the experience of muscle fatigue, anaerobic respiration, and oxygen debt. In a similar fashion tendons and ligaments are discussed in regard to their relation to muscle and bone.

The topic ends with a listing of two malfunctions associated with locomotion: arthritis and tendonitis.

Teaching Strategies: *An Overview*

Renewed interest in athletics, exercise and health regimens have created a new profession entitled sports medicine.

Every student in the class will be able to relate an experience, personal or vicarious, concerning a broken limb, sprain, or strain.

Students will understand that a knowledge of our musculo-skeletal system can allow us to exercise properly, efficiently, and with less chance of self-injury.

Use of skeletal models for comparative study is effective. Students can easily relate why a cat or dog is more swift and better coordinated than man. Use this unit as a tie-in to all of the previous units. Coordination, transport, nutrition, and excretion all permit for smooth functioning.

Teaching Strategies: *Sequential*

1. Display x-ray showing skeletal structures. Ask students to provide functions for the skeletal system. Relate locomotion to muscular system. Display skeleton, charts, assorted bones. Discuss function of bones as anchorage sites for muscle action, leverage for body movement, and production of blood cells in marrow.

2. An x-ray of a fetus will usually display the presence of cartilage in areas where bone will be deposited. Define and distinguish among cartilage, muscle, tendons, and ligaments.

3. Utilize student reports and/or guests from the Arthritis Foundation to discuss arthritis.

Performance Objectives

Students will be able to

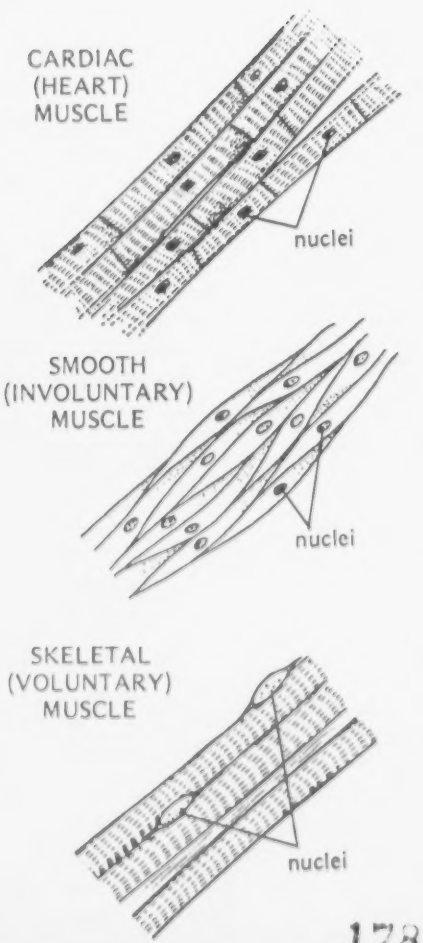
- discuss and distinguish between the structure and function of bone, cartilage, muscle, tendon, and ligament.
- compare embryonic and adult skeletal structure.
- describe the characteristics of skeletal, smooth and cardiac muscles.
- explain the function of tendons.
- locate the sites of ligaments in a human and describe their function.
- report on arthritis and tendonitis.

Activities

1. [D] X-rays -- Display x-rays of bone as the basis for motivating this topic. Most physicians and hospitals often have sets of x-rays that they do not need to save and may give them to you. Students can be asked to suggest what part of the body is in the x-ray and, on careful review, to describe the condition being diagnosed, e.g., broken bones.

2. [D,L] Animal muscle dissection -- Dissection of lamb or calf shank portion (with large muscles still attached to bones) serves as an excellent demonstration in showing the relationship between muscle, bone, tendon, and cartilage.

3. [D] Cross-section - real bone -- Obtain a cross section and when possible lengthwise sections of bones (cow, sheep). Label parts of bone tissue observed including red and yellow marrow. The fresher the specimen the more that can be displayed. Local butchers will probably be able to provide students with ample samples of bone.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

4. [D,L] Frog or fetal pig dissection -- Frog dissection and/or fetal pig dissection may be used to display muscles. Further dissection displays underlying bone tissue and directs attention to relation between them.

5. [D] Comparative anatomy - skeleton -- Skeletons of different vertebrates may be used to compare skeletal structures. Relate differences in skeletal structures to animal's niche and habitat.

6. [D] Comparative anatomy - skulls -- Comparison of mammalian skulls permits or leads to an understanding of intelligence (brain capacity) and feeding habits.

7. [D,L] Fatigue demonstration -- Fatigue and muscle recovery may be demonstrated by having students perform an activity a number of times (e.g., deep knee bends or step up, step down exercises). Students report on symptoms of fatigue and muscle recovery obtained by rest time or massage.

8. [D] Sciatic nerve dissection -- A skilled technician can prepare sciatic nerve and gastrocnemius muscle preparation in a pithed frog. Some demonstrations are possible: stimulating the sciatic nerve and associated muscle contraction relative to amount of voltage used, muscle with nerve may be dissected out, immersed in Ringer's solution and stimulated. After a period of time the muscle will cease to contract. Students can be asked to explain why.

9. [D] Souring milk -- Souring milk will curdle because of the action of bacteria in the milk. Compare the pH of fresh milk and sour milk. The lactic acid in the milk is caused by a bacterium in essentially the same process as anaerobic respiration in muscle fatigue during vigorous exercise.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

10. [D] Sports medicine -- Display a variety of sports equipment such as bats or racquets. Ask your students to describe what sets of muscles and bones are used in the sports. (A skeleton or chart will be useful. Names are not important, the location is.) What are some problems experienced by athletes? (Tennis elbow, strains, etc.)

11. [R] Reports -- Students research and report on arthritis, tendonitis and other related muscle diseases.

12. [S] Arthritis Foundation -- Invite a member of the Arthritis Foundation to discuss the research being conducted in their area.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Model Lesson Plan

Aim: How do humans carry out the process of breathing?

Performance Objectives: Students will be able to

. distinguish between breathing and respiration.
. trace the path of air through the human respiratory system.
. state a function for each structure in the human respiratory system.

Motivation

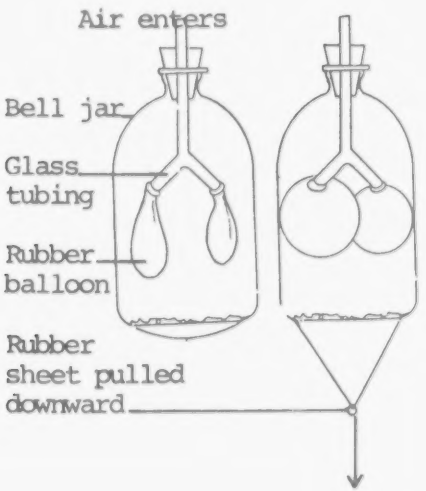
Have a student exhale into brom-thymol blue solution. Time how long it takes for the solution to turn yellow (indicates acid solution). Ask the same student to do jumping jacks or run in place for approximately one minute. Repeat the experiment and compare the rates.

Ask your students to interpret their observations.

Concept: Respiration involves the process of cellular respiration and gas exchange.

Development

1. Provide each student with an unlabeled representation of the human thoracic section as illustrated below.



2. Assign students the task of drawing a series of small arrows to indicate the path of air entering the body. How many structures does the air pass through?

3. By means of a chart or model, have students begin to label the diagram and list the path taken by the air.

Concept: The human respiratory system consists of a series of pathways that permit air from the environment to enter the body and reach the lungs.

4. Students should be asked to trace the path of air on a chart or model and to list the structures on the chalkboard:

nasal cavity
pharynx
trachea
bronchi
bronchioles
alveoli
lungs

5. For each of the structures listed cite a function related to the process of breathing.

6. For this lesson provide a simplistic mechanical overview (e.g., the trachea is a pathway to bronchial tubes). Follow-up lessons can be devoted to specific modifications in structure that are vital to the breathing process (e.g., the trachea has rings of cartilage to keep it open; cilia line the trachea and capture particles sweeping them to the pharynx).

Application: Display a poster of the Heimlich maneuver. Most students have seen this poster in restaurants and probably observed demonstrations on TV. Relate what you have learned during this class period to the procedure described on the poster.

Alternative: Another approach to teaching this topic permits the instructor to discuss in detail each structure of the respiratory system (e.g., nasal cavity, pharynx, trachea) in one lesson. Finally discuss the system in its entirety after the discussion of the lung.

Unit IV: Reproduction and Development

Pages 74 to 90

Suggested time: 15 to 21 days

Unit Theme: All cells arise from other cells by cell division. This phrase introduces the overall theme for this unit.

Students investigate the process of mitosis and meiosis and recognize the role of each in the reproductive process.

A comparison between asexual and sexual reproduction in both plants and animals is supplemented with an understanding of the relationships between numbers of eggs, methods of fertilization, and sites of embryonic development as each relates to the survival of the organism.

Embryonic development in plants and animals relates embryonic tissue to adult structures. Similarities and differences in both kingdoms are emphasized.

Biotechnical mechanisms of hormonal control establish a biological and chemical understanding of reproductive behavior in human men and women.

Topic 1: *Asexual Reproduction*

Topic Theme: The process of mitosis is described in detail without regard to identifying or tagging the names in each stage. Emphasis is on the process, with a logical development of steps that eventually lead to two new daughter cells. A comparison between plant and animal cell mitotic division is presented.

Separate discussion ensues on cytoplasmic division and uncontrolled cell division (animal).

The second half of this topic is devoted to examining types of asexual reproduction including: binary tissue, budding, sporulation, and regenerative and vegetative propagation. Examples are provided for each mode of reproduction.

Teaching Strategies: *An Overview*

Review the basic premise of biogenesis and the cell theory, e.g., omnia cellula y cellula - preexisting living cells produce new cells.

Display a sterile Petri dish and compare with one that was inoculated 24 to 48 hours before class. How was it possible for a few cells to produce billions of offspring in such a short period?

Students will be familiar with many of the examples provided for asexual reproduction but will not be aware that the stagnation in pond water leads to asexual reproduction of microorganisms.

Understanding the process of mitosis necessitates active involvement by your students. Simply distributing previously prepared material will not suffice. Students must observe microscopic slides, charts, and pictures and be obligated to draw and label what they observe. Without a firm, concrete understanding of mitosis; teaching meiosis will be difficult.

Teaching Strategies: *Sequential*

1. Display a sterile Petri dish and inoculate with bacteria. Observe the following day. Ask students to explain how it is possible to have an organism produce countless copies of itself in a relatively short period. Compare the size of a human egg cell with the fetus. How can a single cell produce trillions of organized copies of itself?

2. Teaching mitotic and cytoplasmic division is accomplished by using models and an unlabeled diagram. The key concept to be developed is the need for exact, accurate replication of the chromosome material. A good follow-up lesson is the onion-root tip lab.

3. Utilize charts or microscopic slides that display plant and animal cell mitotic division. Have your students draw and label each process and write a description comparing each process.

4. Once the process of mitosis and cytokinesis has been learned, the variations of each are relatively easy to describe. Charts, diagrams from texts, and microscopic slides readily allow the students to visualize and describe differences in binary fission, budding, and sporulation.

5. Obtain specimens of starfish (lobster, salamander) to explain how regeneration occurs. Vegetative propagation grafting charts are available in most schools. Samples of vegetation, e.g., onion and potato as described in the syllabus, are easily attainable.

   Emphasize that those methods of reproduction are really modifications of the process of mitosis.

Performance Objectives

Students will be able to

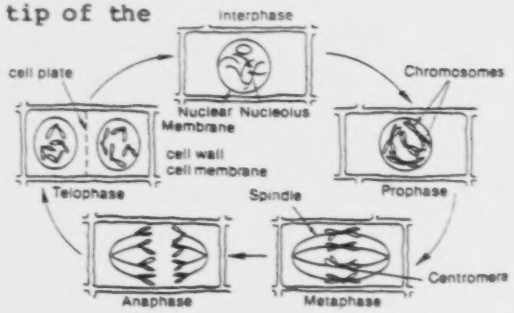
. outline the process of mitosis
. distinguish between mitotic and cell division
. compare plant and animal mitotic division
. predict the outcome of uncontrolled cell growth

Activities

1. [D,L] Onion root-tip mitosis -- Distribute a set of onion root-tip mitosis slides to your students. Ask students to illustrate what they are viewing and to suggest an explanation.

2. [D] Charts and models of mitosis -- Compare visuals of plant and animal mitosis.

3. [D,L] In vivo - prepared onion root-tip cells -- Prepare onion root tip (an area of generally rapid cell division). Stain with Lugol's solution or methylene blue and display. Note: Plan to grow onion roots about 7 to 10 days in advance of the class. Select a section 1 to 2 mm above the tip of the plant. Do not be frustrated; often many tries are required.



Key: D - demonstration, L - laboratory lesson, R - report, S - speaker, P - project

Activities (continued)

4. [D,L] Whitefish egg developments -- Individual laboratory study of preserved slides of whitefish eggs may be used to compare with a similar slide of onion root tip. The object of this lesson is to review the mitotic process with emphasis on comparison with plant mitosis.
Side by side (animal/plant) charts will be useful.

5. [D,L] Pipe cleaner chromosomes -- Utilize colored pipe cleaners to demonstrate pairing and separation of chromosomes.

6. [D] Magnetic chromosomes -- Demonstrate mitotic stages using chalkboard and Styrofoam chromosomes. Hold by magnetic centromeres. Students can be involved in activity at the board.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

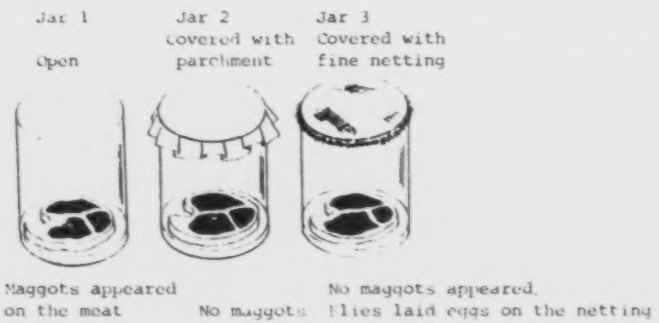
Performance Objectives

Students will be able to

- describe and compare binary fission, budding, sporulation, regeneration, vegetative propagation.
- identify an organism that undergoes each type of asexual reproduction.
- diagram organisms displaying mitosis in each type of asexual reproduction.
- summarize by providing examples and type of plants that display vegetative propagation techniques.

Activities

7. [D] Redi's experiment -- Repeat Redi's experiment (open jar, jar with cheesecloth, jar with plastic). Review with students the concept of biogenesis.



Key: **D** = demonstration, **L** = laboratory lesson, **R** = report, **S** = speaker, **P** = project

Activities (continued)

8. [D,L] Protozoa slides -- Prepared slides of protozoa can be used to demonstrate reproduction by fission. Amoeba or paramecium slides are relatively inexpensive and readily available. [illus. 81]

9. [D,L,P] Yeast fermentation -- Crumble some yeast into a 10 percent sugar or molasses solution. Plug the flask (with cotton, not rubber) and place in a warm place overnight. Prepare a fixed slide preparation (drop of yeast on slide), pass over flame three or four times, and stain with crystal violet. Wash excess. Observe budding in yeast cells. [xerox yeast photo]

Budding in yeast.

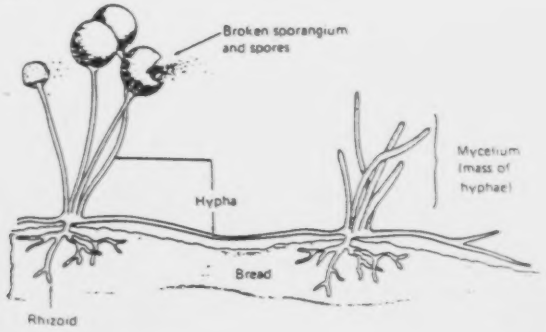
10. [D,L] Tetrahymena in vivo fission -- Tetrahymena is a ciliate that reproduces very rapidly by fission. A typical hanging drop slide will have numbers of these organisms at different stages of reproduction. (Review process of making a hanging drop or suspension microslide.)

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

11. [P,R,S] Cancer cells -- Discuss the rapid series of mitotic divisions of normal and cancer cells (hela cells--cervical cancer cells). Grown in tissue culture can be obtained from research hospitals (Sloan-Kettering). Some students may be motivated to do a research study on the growth of cancer cells. Alternate methods of chemotheraphy and their specific effects on cancer cell metabolism and cell communication is a vital new area of interest. Monoclonal antibodies and recombinant DNA research are also related to studies involving cancer research. Students are well aware of the incidence of cancerous growth in our society.

This topic might help some students to focus on the exciting new frontiers of biological research. Speakers from the American Cancer Society can be invited to classes or groups of classes to discuss research. Students can write letters to other associations and request literature.

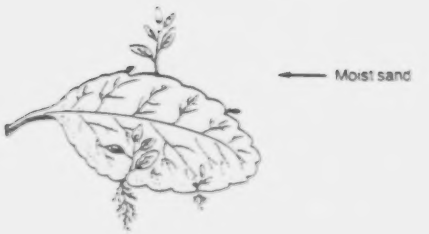
12. [D,L,P] Bread mold -- Sprinkle some dust on a slice of bread (rye bread or white bread purchased in a bakery, not packaged or processed with preservatives). Place premoistened bread in closed container. After several days the black spores of Rhizopus negricans (bread mold) will be obvious. Put a small bit of the mold on a glass slide with a drop of water and observe the spores under low and high power.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

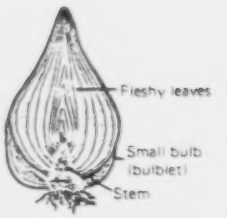
Activities (continued)

13. [D,L,P] Leaf cutting - bryophyte -- Leaf cutting can be demonstrated with the use of a Bryophylla pinnata leaf. Place leaf in wet sand. New growth of small plants will be observed.



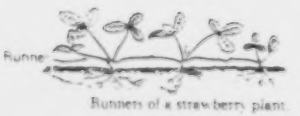
14. [D,C,P] Leaf cutting - begonia -- Place the petiole of a begonia or African violet leaf in moist soil or sand. Observe for root and shoot development.

15. [D,L] Bulb development -- Bulb development may be demonstrated with an onion, daffodil, or other common examples of bulbs. Corms are modified stems. Gladiolus develops from corms.



16. [D,L] Rhizomes -- Grasses such as Bermuda blue grass reproduce by rhizomes or underground stems. The snake plant sansevieria spreads out in a pot in a similar fashion.

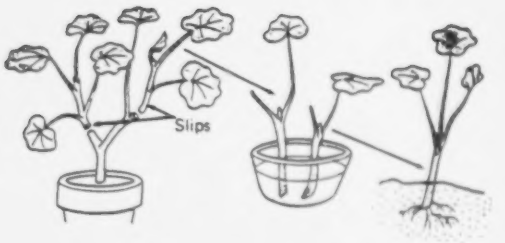
17. [D,L] Runners -- Spider plants may be used to display growth by runners. Spider plants that are well fertilized tend to produce a greater number of smaller plants.



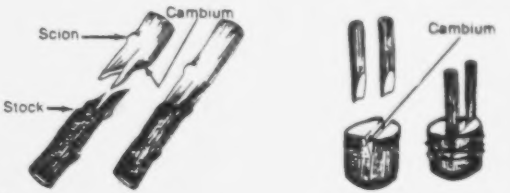
18. [D] Tubers -- Potatoes may be grown from the "eyes" or bulbs of a tuber (thickened underground stem).

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)



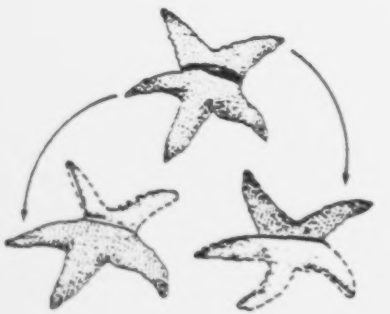
19. [D] Stem cutting -- Begonia, coleus and ivy stem cuttings quickly develop roots when placed in proper medium of wet sand or water. When making the cut, leave about three nodes on the plant and insert about an inch and a half in the medium.



20. [D] Grafting -- Grafting charts are available in most science departments. The variety of techniques displayed show stock and scion placement.

21. [D)] In-arch grafting: tomato/potato -- Potato and tomato plants are very closely related. An in-arch graft is performed as follows: Place stems of two plants (about 10 to 12 inches tall) in contact with each other. Shave off outer skin to expose vascular tissue. Tie off with soft cord or grafting wax. Plants will grow together in about four to five weeks. You can now demonstrate to your class a plant that grows tomatoes above ground and potatoes below ground.

22. [D,L,P] Regeneration in Planaria -- Regeneration in Planaria is easily accomplished but will take nearly three to four weeks to complete. Planaria may be cut in several places or hemispheres. Students can observe the parts that regenerate most rapidly and those that do not regenerate at all.



23. [D,L] Regeneration: lobster - starfish -- Display a dried or preserved starfish or treat the class to a live lobster. Both animals are capable of regeneration. Often lobsters lose a single claw in combat and regenerate the limb back in a relatively short time.

Key: D - demonstration, L - laboratory lesson, R - report, S - speaker, P - project

Activities (continued)

24. [D,L] Regeneration in tubifex worms -- The common annelid, tubifex, can be purchased from local aquarium shops. These worms can be placed in Syracuse dishes and kept at a temperature of 50° to 60°F. Transverse cuts made with a clean razor will show regenerated parts in two to three weeks.

25. [D] Grafting -- Display a three-dimensional grafting board with actual grafts mounted in the device.

26. [D] Multiple fruit trees -- Display pictures of advertisements of dwarf fruit trees. Ask students how one tree can grow oranges, pears, and apples.

27. [D,P,R] Clonal and cell fusion -- Utilize pictures from the March 1976 National Geographic (vol. 150, no. 3) to show new techniques on the frontiers of biological science. Clones of carrot tissue can be discussed. Experimental fusion of plant cells is displayed. Discussion of new plant cell reproduction techniques can motivate students to study science research topics for possible projects.

28. [D] Regeneration -- Display a number of animals that are capable of regeneration, e.g., starfish, lobster. Relate the story of clam farmers who inadvertently cut pieces of starfish and placed them back in the water only to learn that most of the parts had regenerated entire new organisms. Autotomy, loss of a limb or a part of a body (the tail of some lizards, a lobster claw), will also stimulate discussion of types of asexual reproduction.

29. [D,L] Bread mold -- Hand lenses or simple magnifying glasses are perfectly adequate for observing previously grown bread mold.

30. [D,L] Spore anatomy -- Microscopic examination of a variety of spores from a variety of molds can demonstrate adaptations of each.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 2: *Sexual Reproduction*

A. Animal Reproduction

Suggested time: 5 to 8 days

Topic Theme: This topic begins with a statement defining sexual reproduction, gametes, fertilization, and zygotes. The next section is devoted to describing the process of meiosis and a comparison of spermatogenesis and oogenesis.

The process of fertilization is expanded to include characteristics of animals that have external and internal fertilization. Embryonic development is traced through cleavage, gastrulation, differentiation, and what the text refers to as growth.

Extended units concentrate on the male and female reproductive systems and the role of hormones in regulating the reproductive systems. Placental development through the postnatal period is discussed.

The topic ends with a study of reproduction in flowering plants. Adaptive concerns, e.g., the problem of reproduction in a dry, external environment, are intertwined with structural information.

Teaching Strategies: *An Overview*

Allow your students to speculate on the problems inherent in asexual reproduction for multicellular organisms. The need for special organs with the purpose of developing gametes should then be established. As with mitosis, steps in meiosis must be taught sequentially with emphasis on student participation vis a vis observations and drawings.

Present the male and female reproductive systems in a serious, objective manner. Don't be surprised if students begin to ask personal questions regarding the systems. Handle them expeditiously.

Teachers will find this unit, within expectations, to be one of the most self-motivating. It also has a great deal of information, much of it new to your students.

Teaching Strategies: *Sequential*

1. Why would it be impractical, indeed impossible, for a multicellular organism, such as man, to produce another organism in mitotic division (binary fission)? Introduce the need for sexual reproduction by defining and describing the gametes and reviewing the concept of haploidy and diploidy.

2. Allow your students to observe and explain the consequences of producing gametes by the process of mitosis. A need for reduction division should be appreciated. Utilize models, charts, and diagrams to visualize the process of meiosis and compare each stage with mitotic division.

3. Produce schematic flow charts, side by side, of the process of spermatogenesis and oögenesis. Students should be required to explain the functional adaptation of unequal division in oogenesis resulting in <u>one</u> egg cell as opposed to the equal division in spermatogenesis resulting in four sperm cells.

4. Display samples of terrestrial and aquatic animals. Relate habitat to problems related to fertilization. Define external and internal fertilization.

5. (Extended) Using models and microscope slides in conjunction with diagrams, allow students to draw, trace, and label the early stages of embryonic development. A chart listing the embryonic germ layers and resulting adult tissue is a must for this section.

6. (Extended) Compare and display the eggs of a fish or amphibian with that of a hen. How do these differences allow each of these animals to develop? Provide for dissection of a hen's egg. Structures should be drawn and clearly labeled. Chart the four extra embryonic membranes and list a function for each.

7. Although the female reproductive system is covered in the extended unit, it is very difficult to teach or understand the development of a placenta and its function without a clear understanding of the reproductive structures involved. There are excellent films and three-dimensional plaques in addition to text pictures that satisfactorily represent the female reproductive structures and the process of gestation and birth. The section is self-motivating and provides for a great deal of inherent interest. Relate new procedures of in vitro fertilization and surrogate parenting. A picture of a kangaroo or opossum should not be difficult to obtain. Both will permit the student to visualize adaptation for development in marsupials.

8. (Extended) Quickly review the process of gametogenesis and fertilization in man. Trace the production of sperm and egg by implicating structures responsible for each step in the process. Students should be obligated to label the structures of the male and female reproductive systems while providing a function for each.

9. (Extended) The menstrual cycle should be presented with recognition of a number of related topics:

- biofeedback mechanisms for hormone control
- the process related to the female reproductive system
- the process related to preparing the system for fertilization, implantation, placental development, and birth
- the process related to that situation that occurs when fertilization does not happen

10. (Extended) Innumerable visual aids are available that represent the process of birth, although the syllabus makes cursory reference to this topic. The interest and indeed importance of understanding how birth occurs and how the fetus is delivered and cared for in the time immediately following birth should not be neglected. Also a discussion of postnatal development and the aging process will allow students to contribute personal experiences and references.

Performance Objectives

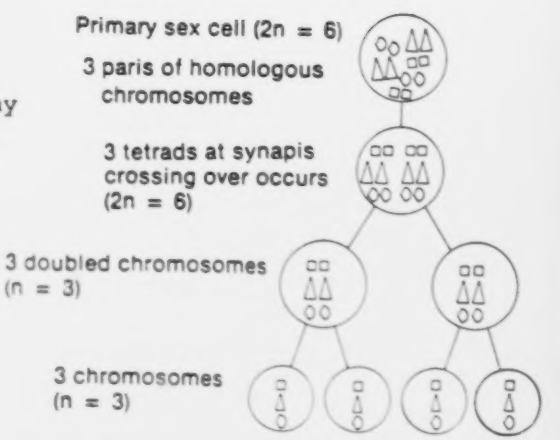
Students will be able to

- describe the process of gametogenesis (spermatogenesis and oogenesis).
- distinguish between the first and second meiotic division.
- compare meiosis with mitosis.
- discuss and compare external and internal fertilization.
- outline the process of embryonic development.
- (Extended) describe cleavage, gastrulation, differention and growth of an embryo.
- (Extended) review external embryonic development in water and land forms.
- compare internal development in placental mammals and marsupials.
- (Extended) list the structures and state a function for each part of the male and female reproductive systems.
- summarize the four major stages of the human menstrual cycle.
- outline and compare prenatal, birth, and postnatal processes of development.

Activities

1. [D,L] Hen's egg -- Display a hen's egg. Ask your students to explain why it is unlikely that the store-bought egg could develop into a chicken. If possible obtain a fresh ovary and the oviduct of a hen from your local butcher. Students should be able to understand the need for identifying structures involved in gamete production and fertilization.

2. [D] Models-charts meiosis -- Models, charts of meiosis: spermatogenesis and oogenesis.


Primary sex cell (2n = 6)
3 paris of homologous chromosomes
3 tetrads at synapis crossing over occurs (2n = 6)
3 doubled chromosomes (n = 3)
3 chromosomes (n = 3)

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

3. [D] Human mannequin -- Human mannequin, charts to demonstrate reproductive systems.

Dangerous Vapors

4. [D,L] Drosophila chromosomes -- The salivary gland chromosomes of drosophila can be extracted and stained. Salivary glands can be extracted under a dissecting microscope in a 0.7 percent sodium chloride solution. Acetocarmine stain (2 drops) is applied to the salivary gland. Crush the glands on the slide by pressing a coverslip against them. Chromosome banding and puffing can be observed.

5. [D,L] Fertilization of frogs' eggs -- Spermatazoa and ova from dissected frogs can be used to demonstrate in utero fertilization and development. Students can view live sperm locomotion. Cleavage in early stages can be observed. Each Syracuse dish used should use pond water isotonic and isothermic for the cells. Aquarium stock water can be modified to foster good development.

6. [D,L] Frog/fetal pig dissection -- Dissection, either demonstration or lab lesson: Since all of the systems have been discussed prior to this topic, it is logical (if it has not already been done) to provide for dissection of preserved frog, fetal pig, or rat. Expertise will dictate approach, as will the readiness of your students.

7. [D,L] Prepared testes slides -- Prepared microscopic slides of cross section of animal testes will display seminiferous tubules and sperm at various stages of development.

8. [D,L] Cyclops/daphnia hanging drop slide -- An interesting diversion from mammalian reproduction may be in displaying living cyclops and daphnia. Locate the egg sacs. Compare the number of male and female daphnia. (Male intestine has a straight tube, female has a curved end.)

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

9. [D] Fetal pig uterus -- Display the uterus with fetal pig (both items available from science suppliers). Ask students to identify structures and explain how each is related to the other.

10. [D] Reproductive structures -- Mannequins are useful in demonstrating reproductive structures. Appropriate charts should be displayed concurrently.

11. [D] Reproductive adaptations -- Display photographs or dissections of reproductive systems in various mammals, birds and frogs. Students should compare and discuss adaptations in each organism.

12. [D] Menstrual cycle -- Menstrual cycle plaques are commercially available for reviewing this system. Complement the plaques with textbook pictures and flow charts.

13. [D] Fetal development -- Models of fetal development and the process of birth may be used to display the steps described in the syllabus.

14. [D] Life histories -- Preserved life histories of pig, rat, and frog are useful for this topic.

15. [D,L] Starfish egg development -- Review cleavage development by demonstrating or using for lab purposes microscopic section of the early stages of cleavage in starfish eggs. Two-, four-, and eight-cell stage as well as the morula, blastula, and gastrula stages may be found on the slides. Can serve as excellent review or as motivation for human development.

Key: **D** = demonstration, **L** = laboratory lesson, **R** = report, **S** = speaker, **P** = project

16. [D] Miracle of Life, an absolutely excellent Nova television program on the development and birth of a child, develops this unit in a manner that cannot be duplicated from any other source.

17. [D] Thermostat feedback mechanisms -- Relate feedback mechanism of thermostat to hormone control in human menstrual cycle. The thermostat need not be a working model for this demonstration. Your school custodian probably has some that he wishes to part with. (Alternate: A bimetallic strap can be used to demonstrate the thermostat mechanism for monitoring changes in temperature. This can be related to blood levels of hormones.)

18. [D] Magazine photographs -- Obtain from school libraries photographs from Life magazine (reprints), the series showing the birth process and prenatal development.

19. [P,R] Museum trip -- Visit the Hall of Man at the American Museum of Natural History. Perspectives of all aspects of biology from cell theory to ecology can be found in this single major exhibit.

B. Plant Reproduction

Pages 86-89 **Suggested time: 4 to 6 days**

The topic of sexual reproduction ends with a study of reproduction in flowering plants. Adaptive concerns, e.g., the problem of reproduction in a dry, external enviroment, are intertwined with structural information.

Teaching Strategies: *An Overview*

Florists generally maintain a stock of gladiolus throughout the year. Although the cost will vary depending on availability, a single stem may contain 8 to 10 buds (75 cents to $1.00).

This topic lends itself to innumerable student projects, e.g., germination of seeds and plant growth, many of which can be done at home with minimal cost. Seeds need not be purchased. Ask students to bring in beans and other seeds that they may have at home. Amaryllis plants can be used to actually show pollination and seed formation.

Teaching Strategies: *Sequential*

1. Display a number of seeds. Ask your students to explain how the seeds developed. Provide time for a flower lab. Models of flowers, charts, and diagramming are a must for this topic.

2. Ask your students to explain why a field of plants, sprayed with an insecticide, result in flowers that produce few seeds. The relationship between insects and pollination should be established. Hay fever or pollen-allergic individuals should be asked to explain why their symptoms occur at certain times of the year and not at other times.

List methods of cross- and self-fertilization. State adaptations, advantages, and disadvantages of each.

3. Double fertilization and embryo development in flowering plants should be compared with the process of fertilization and development in animals. A good opportunity exists at this time to review and relate both topics.

4. Dissection of monocot and dicot seeds, once more held in conjunction with charts, models, and diagrams, provide students with a knowledge of seed structure and germination. Each structure identified in the seed should be related to its role in the process of germination.

5. Review plant transport and storage tissue. Display and discuss a cross section of stems that show annual rings. In a similar fashion observe growth in length, both stems and roots. How does growth in plants differ from that in animals? Use charts, diagrams, and other visuals to enliven this topic.

Performance Objectives

Students will be able to

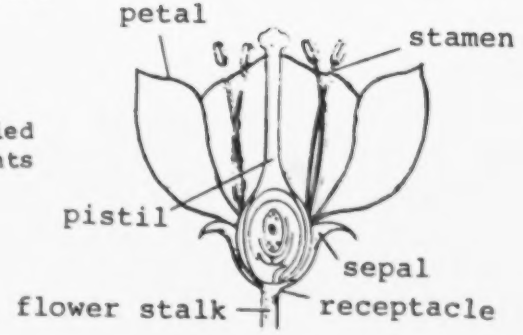
. describe the structures of a flower and state a function for each.
. recall the significance and adaptation for the process of pollination.
. outline fertilization and embryo development in flowering plants.
. explain the requirements for germination
. review the process of growth in multicellular plants

Activities

1. [D] Flower growth -- Display on demonstration desk a flower, seed, fruit, and newly germinating plant. Ask your students to place the items in correct order of plant development.

2. [D] Flower lab dissection (gladiolus) -- Dissection of flower: Use gladiolus for its clarity and ease of dissection which may be easily carried out and is relatively inexpensive (about 7 to 10 buds per flower at 75 cents to $1.00).

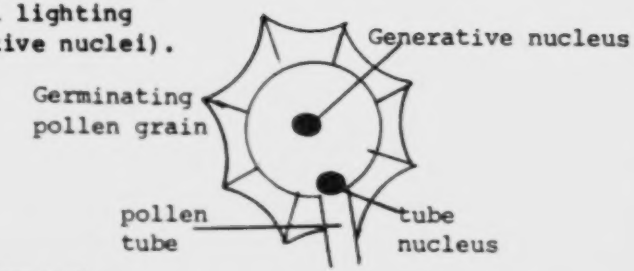
3. [D] Use models and charts of floral structures.



4. [D] Charts on bean and corn seed germination -- Teacher might enliven this display by preparing in advance germination of seeds for display and/or microscopic examination.

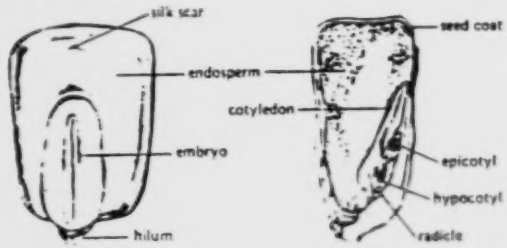
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

5. [D] Pollen tube growth -- Instructor can grow pollen tubes that can be easily observed under low power of microscope. Place pollen on 10 g sucrose solution (hanging drop or Vaseline ring will be satisfactory). Place slide in incubator or in relatively warm place for 1 to 2 days. Under ideal lighting conditions 3 nuclei may be observed (1 tube nucleus and 2 reproductive nuclei).



6. [D,L,P] Seed/fruit dissection -- A variety of fruits may be dissected, structures identified, and primary mode of dispersal hypothesized. (Vegetables are also fruits.) Beans or pea pods are relatively inexpensive and give an excellent representation of ovaries and ovules (seeds and fruit).

7. [D,L] Monocot - dicot seeds -- Collect a variety of monocot and dicot seeds (corn seeds and lima beans). A few days before the demonstration, allow the seeds to soak in water. Dissect, compare, and label. Excellent charts for display are useful in this exercise. (Indeed in all dissections, the use of a chart on display is educationally sound.)



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

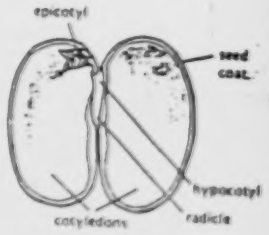
8. [D,L,P] Seed inbibition -- A rather dramatic display of seed inbibition and pressure can be demonstrated by filling a small plastic or clay flowerpot with lima beans. Place the pot in a pot of water. Within 24 hours the bean seeds will have absorbed so much water that the flower pot will be broken into a number of pieces.

9. [D,L,P] Seed temperature variable -- Demonstrate the effect of temperature on seed germination by placing a number of similar seeds in Petri dishes (as illustrated). Place one in refrigerator, one at room temperature, and a third in an incubator. Compare and explain results.

10. [D,L,P] Seed oxygen variable -- The need for oxygen may be shown by placing seeds into containers filled with cotton and saturated with water. Leave one jar open. Seal the second. Observe and explain.

11. [D] Sealed micropyle effect -- The micropyle aids in the entrance of water within a seed. Seal the micropyle in a number of seeds (wax or rubber cement). Place these prepared seeds with a number of regular seeds into separate beakers of water. After a period of time, two to three hours, remove from the beakers. Lay on a paper towel, weigh, and compare.

12. [D,L] Bean seed dissection -- Soak bean seeds (overnight) so that they may be easily dissected. Compare with pictures or charts and models. Draw and label.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Model Lesson Plan

Aim: How are new organisms reproduced asexually?

Performance Objectives: Students will be able to:

. define asexual reproduction.
. describe the process of binary fission, and budding.
. provide examples of organisms that reproduce by fission or budding.

Motivation

Distribute a set of commercially prepared paramecium or amoeba fission slides. Cover the identifying label and ask students to observe, draw, and indicate what they observe.

Concept: Asexual reproduction is the production of new organisms without the fusion of nuclei. The new organisms develop from the parent cell or cells.

Development

1. Use charts and microscope slides to illustrate the process of fission in the amoeba and paramecium. Students should compare the process of fission to that of mitosis.

Concept: Binary fission involves the equal division of nuclear materials and cytoplasm resulting in two new organisms.

2. Prepare in advance of this session a yeast culture. (Look at suggested activities.) Instruct your students to prepare a slide using a single drop of the culture. They should draw what they observe and compare with fission concept.

   Budding is similar to fission except that the cytoplasm divides unequally. The two new cells may remain attached and form a colony or detach from each other.

Application

How might the processes of fission and budding lead to events resulting in multicellularity? (Refer to colonial protozoa, volvox, etc.)

Unit V: Genetics

Pages 92 to 106

Suggested time: 14 to 22 days

Unit Theme: Genetics is the study of heredity as directed toward the understanding of the mechanisms of the transmission of traits beginning with Mendel's classical research and laws. The work of Morgan, Sutton and others is discussed in establishing the gene-chromosome theory.

Advances in biochemical technology have led to determining the structure of genes and to explanations regarding their role in the production of proteins and the regulation of cellular activity.

Discovery of the genetic code has led to the latest developments in genetics, namely, genetic manipulation, cloning and recombinant DNA.

Topic 1: *Foundation of Genetics*

Topic Theme: Gregor Mendel's experiments developed the laws of dominance, segregation and independent assortment. Morgan and Sutton's research elaborated on Mendel's research with the development of the gene-chromosome theory.

Teaching Strategies: *An Overview*

Mendelian experiments should be utilized as a motivation for the study of human traits. The classic experiments of Mendel, Sutton and Morgan are a suitable foundation for modern studies. Student observations of demonstrations of plant inheritance allow for interesting lessons.

Teaching Strategies: *Sequential*

1. A detailed study of Gregor Mendel's experiments with pea plants helps motivate students to enjoy the results of controlled experiments. The decisions relating to organisms studied and traits to be considered allows students to learn some of the techniques involved in experimentation. Deriving Mendel's laws by utilizing examples of his experiments helps students to understand mechanisms for the transmission of hereditary factors.

2. Continuing with a historical approach, Morgan's and Sutton's research can be studied in a parallel fashion. The choice of organism, the technique used, and the tracing of experimental pathways yield valuable information leading to the establishment of the gene-chromosome theory.

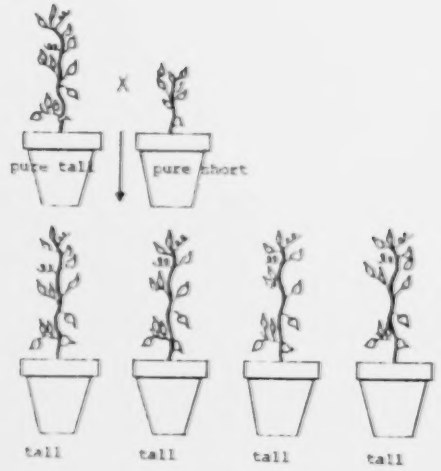
3. Mendel's laws of dominance, segregation, and independent assortment can be further elaborated by using many examples of animal, plant, and human heredity. The gene-chromosome theory can be applied to similar situations using flowcharts, as well as the Punnett Square.

Performance Objectives

Students will be able to

- relate Mendel's experiments to the development of the laws of dominance, segregation and independent assortment.
- list the steps in the passage of traits from P_1, to F_1, to F_2 generations.
- relate the structure of the pea flower to the success in Mendel's experiments.
- distinguish among the following terms: dominance, recessiveness, segregation, independent assortment, hydrid, pure, heterozygous, homozygous.

Activities



1. [D,L] Pea plant -- Use the model of the pea plant to demonstrate the P_1, F_1, and F_2. Generations in self-pollinating plants. Relate the structure of the pea plant to its role on Mendelian research.

2. [D,L] Hybrid crosses -- Obtain F_1 seeds of peas or sorghum and plant. Ask students to describe the results from crosses of F_1 pure-tall and short. Compare with F_2 hybrid crosses.

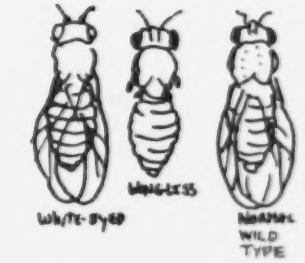
3. [D,L] Hybrid coin toss -- Using coins, a penny and a nickel (male and female), the head side of each is T, and the tail side of each is t, show possible matings of the male and female hybrids. Develop results in a Punnett Square. Ask students to explain differences between phenotype and genotype.

4. [D,L] Charts, models -- Show a model, a drawing, or a picture of a garden pea. Ask: "Why was it fortunate that Mendel selected the garden pea as a model for his experiments?"

Performance Objectives

Students will be able to

. discuss the experiments of Morgan and Sutton in establishing the theory of genes and chromosomes.
. compare Mendel's experiments to those of Morgan and Sutton.



Activities

1. [D,L] Display fruit flies and discuss their life cycle.

2. [D,L] Use a laboratory period to study salivary gland chromosomes of fruit flies.

3. [D,L] Read Morgan and Sutton's research procedure and have students compare studies to Mendel's work with pea plants.

4. [D,L] Charts and models -- Use charts and models to demonstrate various laws and concepts in genetics.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 2: *Some Major Genetic Concepts*

Topic Theme: Mendelian inheritance provided the basis for future studies which expanded the genetic theory. Occurrences of intermediate inheritance, linkage, multiple allele trait formation, and crossing over are explained and have added to the understanding of inheritance.

Teaching Strategies: *An Overview*

The classic research of Mendel and Morgan can be utilized to teach the concepts relating to dominance, segregation, and recombination, intermediate inheritance, independent assortment, gene linkage, crossing over, multiple alleles, sex linkage, and sex determination. The use of the results gained from the classical experiments that helped formulate Genetic Theory can be applied to specific examples. The use of current news articles can help students to apply these concepts present-day situations.

Teaching Strategies: *Sequential*

1. The teaching of the concept of intermediate inheritance (incomplete dominance or codominance) can be introduced by discussing the idea of dynamic changes in current scientific concepts in genetics. There are many examples of organisms that are hybrid (heterozygous) for a trait and have a different phenotype for that trait than either of their parents who may be homozygous (pure) for that trait. Specific case scenarios for the inheritance of blood type (A, B, O) and sickle cell anemia, as well as color of offspring (Andalusian fowl and four o'clock plants) can be traced to show the passage of genes and their expression in the parents (P_1) and succeeding generations (F_1 and F_2).

2. The gene-chromosome theory can be utilized to explain independent assortment and linkage. Many models, charts, and film loops can demonstrate the movement of chromosomes in mitotic and meiotic divisions of the nucleus. The effects of these movements can be applied to the concepts of linkage, independent assortment, and crossing over.

3. Teaching the concept of multiple alleles can be applied to situations where blood type identification has been utilized in baby switching situations and paternity suit investigations. The international symbols for blood types should be used in these exercises.

4. Morgan's research with sex linkage in determining the transmission of eye color in fruit flies can help students solve the puzzle of traits that are linked to the X chromosome (sex linkage). Examples of the traits of hemophilia and colorblindness can be discussed. Use of Ishihara's test for colorblindness can motivate students by providing a real-life example of a trait that involves sex linkage.

5. Students should experience the situations in studying experimental research where ratios obtained do not express the classic ratios. The concept of mutation can be introduced. Any change in genes or chromosomes can lead to situations that are new for individuals. The study of conditions where chromosome numbers have changed or where genes have changed can be interesting to students. The practical use of situations involving human heredity allows students to relate their familial experiences to the topic.

Performance Objectives

Students will be able to

- define the following: dominance, segregation, recombination, intermediate inheritance (incomplete), independent assortment, linkage, sex linkage, multiple alleles, crossing over, and sex determination.
- discuss gene-chromosome theory as it applies to the terms written above.
- list common examples of traits related to the above terms.

Activities

1. [D,L] Nuclear control -- Acetabularia, a one-celled marine algae, can be used to demonstrate nuclear control and its effect on cytoplasm. Cap and stalk replacement is very difficult. Thus pictorial representations are usually more effective.

2. [D,L] Linkage -- Ask a student who has red hair and freckles to discuss his family traits related to hair color and skin pigment. (Alternative: Show pictures of humans with red hair and freckles.)

3. [D,L] Sex linkage -- Demonstrate Ishihara's test for color blindness. Ask students why more males have this trait.

4. [D,L] Giant chromosomes -- Demonstrate the presence of salivary chromosomes in drosophila. Discuss Morgan's fly squad.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

5. [D,L] Family pictures -- Display pictures of children and parents (human or animals); have students compare and explain resemblances.

6. [D,L] Poppet bead -- Use poppet beads to demonstrate linkage and crossing over.

7. [D] Mendel revisited -- Have class read a translation of Mendel's paper. Discuss how modern research affects his work and reports.

8. [D,L] Project with guppies -- Have students experiment with heredity of guppies. Brown and golden are alleles of the wild type and illustrate Mendel's laws. Platys unspotted and spotted (dominant) can also be studied.

9. [D,L] Human traits -- Discuss some recognizable dominant and recessive traits in man, i.e., ear lobe, curling of tongue (dominant) and cleft chin (dominant). Survey the class. Ask students to develop pedigree charts for their families.

10. [D,L] Blood typing -- Review blood typing experiments previously conducted using the microprojector. Elicit the three alleles present for blood type (A, B, O Types).

11. [D,L] Crossing over - mapping -- Demonstrate genetic maps. Ask students to map chromosomes using crossover frequencies.

12. [D] Multiple alleles -- Discuss paternity suits and problems of baby switch problems in genetic cases used in court.

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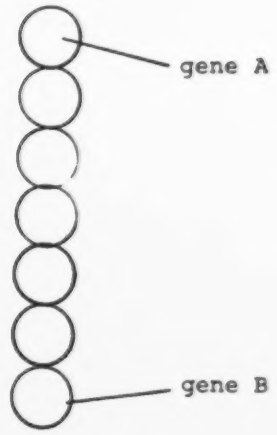
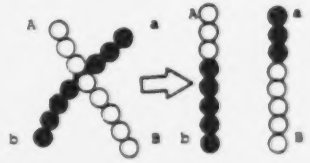




Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 3: *Mutations*

Pages 97 to 99

Suggested time: 3 to 4 days

Topic Theme: Changes in hereditary material that affect gametes may be transmitted from one generation to another. Gene and chromosome mutations affect survival of cells and organisms.

Teaching Strategies: *An Overview*

An underlying theme popular with many textbook publishers is the concept of evolution. Living organisms "change" and in some instances become extinct. How does a species change and develop into a new species? Why do members of a species often possess traits that enable them to be better adapted to survival in their environment? Developing the significance or outcomes of mutations, either beneficial or deleterious, is useful in structuring this topic and making the concepts more meaningful.

Teaching Strategies: *Sequential*

1. (Extended) The specific types of chromosome change (translocation, additions and deletions) can be introduced using various demonstrations such as magnetic model chromosomes, poppet beads and transparencies. All of these devices can show physical causes of chromosomal change.

2. Some causes of mutations (mutagenic agents) can be discussed using news items from the media. Students as young citizens must be made aware of current examples of mutagenic agents found in their environment. A letter writing campaign in class may be utilized by a teacher to involve students in their topic. They can be asked to do research in the library in order to express themselves in an organized and factual way.

Performance Objectives

Students will be able to

- relate genetic changes to the structure of chromosomes.
- discuss how environmental hazards affect genetic mutations.
- compare gene and chromosome mutations.
- discuss examples of human traits caused by mutations.
- discuss translocation, addition and deletions as kinds of hereditary change.

Activities

1. [R,D] Environmental hazards to genes -- Bring in articles about the victims of Hiroshima, Agent Orange spraying, mustard gas used in Afghanistan; distribute copies and discuss in class the effects on humans. Relate Lysenko, Darwin and Lamarck to these discussions.

2. [R,D] Your home environment -- Ask students to make a study of the environment in their home and community. Ask them to list possible causes for concern related to their own reproductive and hereditary mechanisms. Ask them to describe conditions that affect their health and how improvements can be made.

3. [R,D,L] Geiger counter -- Use a Geiger counter to show background radiation. Place a radioactive source near the device. Note the change in reading. Relate to mutations.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

4. [R,D] Hybridization -- Discuss the accomplishments of Luther Burbank. Show pictures of giant zinnias and polyploid water melons. Explain the mechanisms involved.

5. [R,D] Nondisjunction -- Discuss legal cases of Olympic athletes that relate to chromosome aberrations. Discuss chromosome tests used for athletes.

6. [R,D] Chromosome changes -- Discuss Down's syndrome, Klinefelter's syndrome and other cases utilizing pictures of affected humans, and explaining how the condition is inherited.

7. [D,L] Radiation and genes -- Grow irradiated seeds and compare to nonirradiated forms. Discuss affect of x-rays used by Muller. Discuss cancer therapy using radiation. Discuss the potential danger in overexposing the skin to sun.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 4: *Genetic Applications to Animal and Plant Breeding*

Page 100

Suggested time: 1 to 2 days

Topic Theme: Many experiments in agriculture were performed to improve the quantity and to increase the survivability of desired plant and animal species. New procedures such as surrogate parents in cattle, cloning, cell fusion, and recombinant DNA, have been among the most recent developments in this field.

Teaching Strategies: *An Overview*

The use of modern genetic theory in agriculture has been applied in plant and animal breeding. Using current news articles to explore the practical application of genetic concepts is a valuable technique.

Teaching Strategies: *Sequential*

News articles relating genetic applications in agriculture should be fascinating to students. The teacher can motivate lessons by duplicating science news articles relating to animal and plant research. The surrogate parent concept for animals has been attempted with humans. This can be discussed in relation to the practical uses of breeding plants and animals.

Performance Objectives

Students will be able to

. describe classic breeding experiments.
. relate genetic theory to the practical applications of genetic experiments in agriculture.
. relate new ideas in scientific journals to lessening food shortages.

Activities

1. [D] Class visits -- Visit a kennel, arboretum, florist shop, horse farm (race track). Have students discuss animal and plant breeding. (Substitute a visit to or have visitors from a school specializing in agriculture.)

2. [D] Seedless fruit -- Show a number of varieties of seedless fruits. Ask: "How do scientists use their knowledge of genetics to grow this type of vegetation?"

3. [R] News articles -- Distribute copies of the New York Times science articles, or the 1976 National Geographic (vol 150, no. 3) article on plant cloning. Discuss the new genetics as it applies to improving food quality and quantity.

4. [D,L] Problems in agriculture -- Show pictures of horned steers, hornless and Brahman varieties. Ask students to compare these varieties and comment on human progress in agriculture. Ask: "Why is a hornless steer desirable for agriculture?" "Why would it be unlikely to find a naturally occurring hornless steer?"

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 5: *Interaction of Heredity and Environment*

Suggested time: 1 to 2 days

Topic Theme: Genes provide the hereditary potential for cells and organisms. Interaction with the environment provides the balance of influence in the expression of traits and the performance of the life functions.

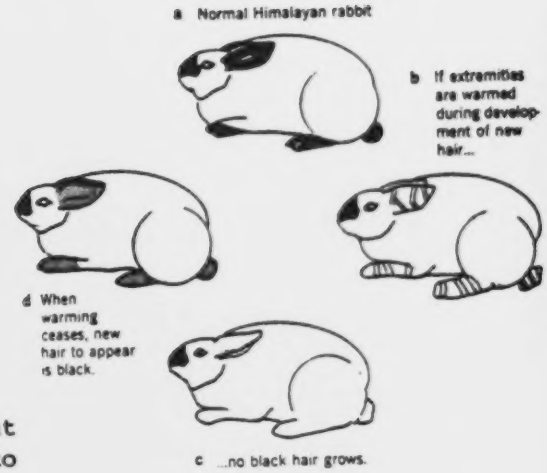
Teaching Strategies: *An Overview*

Once more, news articles can be used to introduce some examples of nature versus nurture. Identical twin studies taken from news articles can motivate students to learn the mechanisms of environmental influence on hereditary material. Providing a desirable atmosphere to learn may help student achievement.

Performance Objectives

Students will be able to

- correlate the factors in the environment which may influence the expression of genes.
- give examples of environmental interaction in living organisms.


a Normal Himalayan rabbit
b If extremities are warmed during development of new hair...
c ...no black hair grows.
d When warming ceases, new hair to appear is black.

Activities

1. [R,D] Environmental influences on gene expression -- Discuss the experiments with Himalayan rabbits. Be sure to display pictures of the species.

2. [D,L] Environmental influence on plants -- Display a sample of hybrid sorghum plants with a three-to-one ratio of green to albino plants. Ask what determined these traits. Expose plants to light and ask what would happen to albino plants. Ask what would happen to plants if the whole container was kept in the dark. Display a second tub of plants with the same ratio of green to albino and ask students to explain the result. Discuss gene function and environmental influence.

3. [R] Human twin studies -- Show copies of news articles on twin studies of actual orphaned identical twins.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

4. [R] Instinct and genes -- Show pictures of instinctual behavior in termite nest building [Scientific American] and spider behavior [Nova film "Life on a Silken Thread"]. Ask students to list arguments for nature versus nurture in humans compared to these animals.

5. [R,D,L] Plant environment studies -- Ask students to use several coleus plants made from identical plants (cuttings) and place samples in varying light conditions. Ask them to find similar examples of conditions around their school grounds.

6. [D,L] pH and plant growth -- In hydrangea plants grown in different environments the pH will change from acid to base; the plant will change flower color. Demonstrate this with several plants. Attempt to reverse the color change.

7. [D,L] Seedlings and light -- Grow seedlings in light and dark. Have students observe chlorophyll production in each group.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 6: *Human Heredity*

Pages 100 to 102

Suggested time: 2 to 3 days

Topic Theme: Human heredity studies have been limited by ethical considerations and the difficulty in performing longitudinal studies. Modern clinical techniques and the field of genetic counseling have assisted many couples seeking information.

Teaching Strategies: *An Overview*

The introduction of modern techniques used in studies of human heredity can be applied to current medical practice. The extended area dominates in this section. Applying this topic specifically to human disorders is of interest to students. Articles from research foundations can be read by students to prepare at home for class discussion.

Teaching Strategies: *Sequential*

1. A discussion of human heredity will reveal contemporary techniques in genetic counseling. The techniques of any amniocentesis and karyotyping should be reviewed and related to the advances in predicting the hereditary makeup of developing fetuses.

2. (Extended) Research specific human disorders (Tay-Sachs disease, sickle cell anemia, phenylketonuria).

Performance Objectives

Students will be able to:

- describe the technique of karyotyping and give examples of its use in detecting Down's syndrome and genetic disorders.
- explain the technique of amniocentesis and give examples for its use in genetic counseling.

Activities

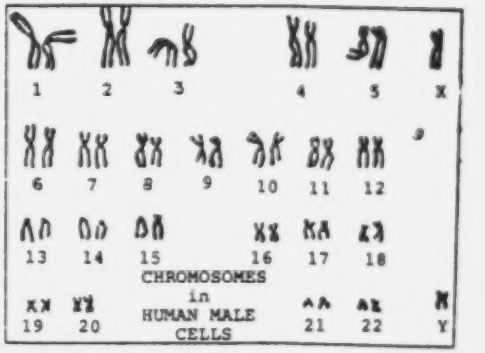
1. [D] Family traits -- Display family pictures showing father, mother and children. Ask students who each child resembles. Develop concept of continuity and diversity.

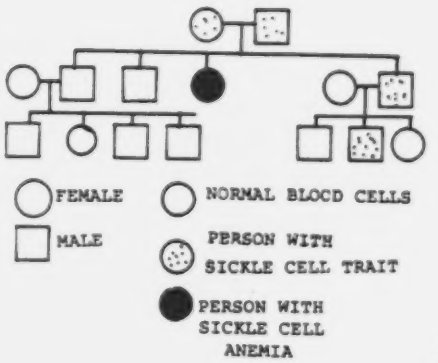
2. [D] Human karyotypes -- Display pictures of human karyotypes. Elicit the techniques used to prepare them and their use in genetic counseling.

3. [R] Genetic counseling -- Distribute pamphlets obtained from various foundations describing genetic counseling and scientific techniques.

4. [D,R] Human genetic disorders -- Obtain films from associations such as Sickle Cell Disease Foundation, March of Dimes, and others. Use selected films to demonstrate modern techniques.

HUMAN KARYOTYPES





Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 7: *Modern Genetics*

Pages 102 to 106

Suggested time: 3 to 5 days

Topic Theme: Recent developments on recombinant DNA research has demonstrated man's ability to restructure this molecule, insert it into certain organisms, and literally create a new life form. The development of this technique reflects the advances in science from identification of structure to explanation of functions -- a development which has now allowed restructuring genes hopefully for the improvement of society.

Teaching Strategies: *An Overview*

The topic of modern genetics allows the teacher to stress the specific relationship of the structure of the DNA molecule to its role in controlling the activities of the cell. The role of DNA in replication and protein synthesis can be discussed logically by using models and board diagrams. Magnetic models of DNA or transparancies can be used to simulate the processes involved.

The Hardy-Weinberg principle can provide insight in explaining the genetic pool. Darwinian theory is enhanced by using the diagrammic view of genes in populations through the use of the Hardy-Weinberg equation.

Teaching Strategies: *Sequential*

1. Review the history of the discovery of the DNA model. Students love mystery stories; the search for the definitive model is perhaps one of the most exciting scientific adventures.

2. DNA models and charts should be used in conjunction with student generated geometric shapes corresponding to phosphate, sugar and nitrogenous bases. Design a lesson that permits the students to build a DNA model using suggested geometric shapes on p. 102 (syllabus). Provide additional shapes to correspond to each of the four nitrogenous bases.

3. Review the need for exact replication of the DNA molecule. Students should visualize ability of free nucleotides to be attracted to the corresponding nitrogenous base pair; models are a must at this point. Student exercises designed to represent the process are vital (Extended).

4. Using similar models give details and compare the structure of RNA and DNA. Ask your students to explain how the message carried on the DNA molecule is transmitted to the cell's cytoplasm.

Ask them to identify the problems in transmission. By analogy, describe how a supervisor may transmit orders to all parts of an industrial plant. Develop the codon concept by comparison with the Morse code.

5. Distinguish between messenger, transfer, and ribosomal RNA. Protein synthesis review should include concepts of dehydration synthesis and amino acid peptide bond attachment. Once the foundation has been established proceed to develop the concept of protein synthesis.

6. (Extended) The number of genes (genome) present in a species can best be appreciated by having students recognize the significance of the "one gene one polypeptide hypothesis." How can an organism such as a virus with very few genes carry out life activities? The clue: parasites use host genetic mechanisms.

7. (Extended) Students are aware that though the technology related to organ transplants has been well established, the problems of organ rejection is still a prime concern. Relate this problem to the individuality of organisms, even within a species.

8. (Extended) Display a series of words whose meaning may be changed by simply reversing or changing the order of its letters, e.g., meat/ team/ mate/ tame. In a similar fashion, gene mutations may be presented. Addition and deletion can also correspond to words, e.g., meat becomes met or mat or matter.

9. (Extended) One of the most fascinating and indeed most controversial topics in bioethics is in the field of cloning and genetic engineering. Be liberal in the use of newspaper articles and other reports. Encourage panel discussions and student reports.

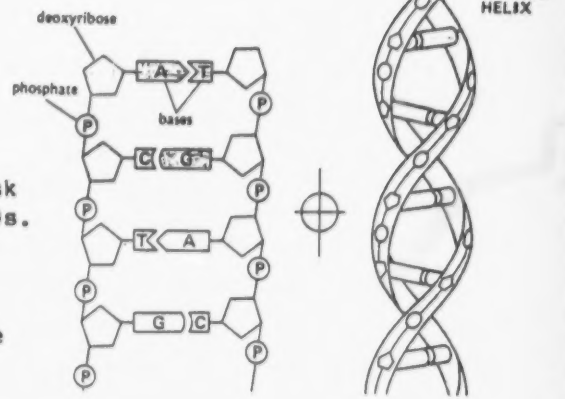
10. (Extended) Students should consider the flow of genes in the world population. The concept of one world and the implied interdependence can be applied in studying the Hardy-Weinberg principle. A discussion of the limiting effect of the size of gene pools can be applied to the evolutionary patterns of specific groups in our country and in other areas of the world.

Performance Objectives

Students will be able to

- trace the discovery of the structure of DNA and the application of this knowledge to determining DNA's function in cells.
- discuss the synthesis of DNA from building blocks.
- (Extended) describe replication and protein synthesis using the model of DNA molecule.
- (Extended) discuss the Hardy-Weinberg principle and apply it to human populations.
- (Extended) define and give examples of cloning, genetic engineering, one-gene one-enzyme theory, population genetics.

Activities



1. [D,L] Structure of chromosomes -- Use poppet beads to demonstrate chromosome structure.

2. [R] Structure of DNA -- using a model of DNA, read portions of James Watson's book, The Double Helix (New York: New American Library, 1968). Ask students to comment on the implications of the research in the 1950s and 1980s.

3. [D,L] Paper chromatography -- Using paper chromatography, demonstrate the identification of purine and pyrimidine bases.

4. [D,L] One gene, one enzyme -- Use the neurospora mold to grow normal and irradiated spores (Biological Science Curriculum Study Blue version text, 1961, page 153-160).

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

5. [D,L] Pedigree charts -- Ask students to prepare family pedigree charts for three traits. Discuss the experimental data gathering and explain the results.

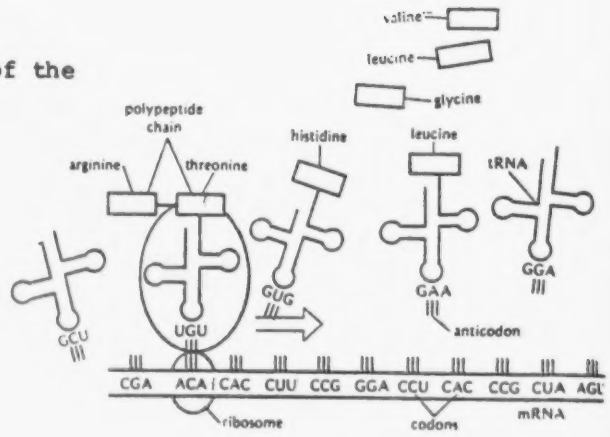
6. [R] Human traits -- Discuss the "Founder principle" of six finger traits in the Amish population.

7. [R] Human traits -- Hemophilia studies using a pedigree chart of the royal familes in 19th century Europe can demonstrate gene pools.

8. [R] (Extended) Cloning -- J.B. Gurdey's experiments in cloning can be demonstrated using pictures from the 1976 National Georgraphic, (vol. 150, no. 3), "The New Biology: The Awesome Worlds Within a Cell."

9. [D] Operon theory -- Distribute copies of Scientific American articles describing gene action. Demonstrate operon theory of Jacob and Mounod by use of transparencies.

10. [D] Protein synthesis -- Use a large slide rule (physics and math departments have these models; paper ones can be built). The movement of the slide rule transparent liner can demonstrate the functioning of DNA in specific cells of different tissue.

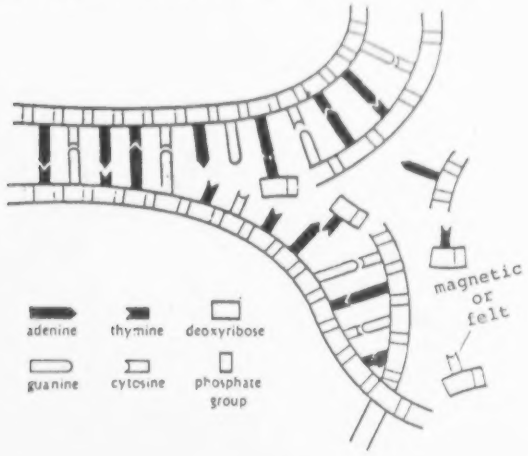


Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

11. [D] DNA molecule -- Use models and magnetic DNA templates to demonstrate duplication and protein synthesis.

12. [D] DNA replication -- Use a zipper to show the nature of DNA replication.



13. [D] Protein synthesis -- Use magnetic models or transparencies to develop the concept of protein structure and cell synthesis. Compare the process to "communication of cells."

14. [D] (Extended) Cell communication and DNA -- Play the telephone game by asking students to relay a message from one to another (use ten students). Elicit the problems of class communication and ask how this can be applied to cell communication. Elicit the possible problems with cells, e.g., cancer, if communication is faulty.

15. [D] Demonstration techniques -- Felt cutouts, magnetic discs or transparency overlays may be used to demonstrate various aspects of modern genetics.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Model Lesson Plan: *Foundation of Genetics*

Gregor Mendel's experiments developed the laws of domination, segregation and independent assortment. Morgan and Sutton's research continued where Mendel left off in the 1850s with the development of the gene-chromosome theory. The idea of genetic variation produced by mutation added to Mendel's concepts of the dominance of genetic characteristics.

Aim: How are traits inherited?

Performance Objectives: Students will be able to:

. relate Mendel's experiments to the development of the concepts of dominance, segregation, and independent assortment.

Motivation: Display family pictures showing father, mother and children. Ask students who each child resembled.

Activities

1. Use the model of the pea plant to demonstrate the P, F, and F_2 generations in self-pollinated pea plants. Relate the structure of the pea plant to its rose in Mendelian research.

2. Obtain F_1 seeds of peas or sorghum, and plant them. Ask students to describe the results of crosses of F_1 (pure tall and short). Compare to seeds (F_2) from hybrid crosses.

3. Using Acetabularia, a one-celled marine algae, demonstrate the control of the nucleus and its effect on cytoplasm. Mendel's characters can be demonstrated by removing stalk and cap of this plant and replacing the parts and observing the influence of the nucleus found in the rhizome or the stalk. (Pictures can be used.)

4. Using coins, a penny and a nickel (male and female), the head side of each (T) and the tail side of each (t), show possible matings of the male and female hybrids. Develop results in a Punnett Square. Ask students to explain differences between phenotype and genotype.

5. Discuss some recognizable dominant and recessive traits in man, i.e., ear lobe, curling of tongue (dominant), and cleft chin (dominant). Do a survey of numbers in class. Ask students to develop pedigree charts for their families.

Model Lesson Plan: *Some Major Genetic Concepts*

Theme: Mendelian inheritance provided the basis for future studies which modified genetic theory. Occurrences of intermediate inheritance, linkage, multiple allelic trait formation and crossing over, have been explained and have added to the understanding of hereditary variation.

Aim: How do traits vary from generation to generation?

Performance Objectives: Students will be able to

- relate variations in hereditary mechanisms, such as dominance, multiple allergic trait, linkage and crossing over, to common examples of traits found in nature.

Motivation: Demonstrate Ishihara's test for color blindness. Ask students why more men would have this trait.

Activities

1. Show blood typing experiments with class using the microprojector. Elicit the three alleles present for blood type (A, B, O type).

2. Demonstrate genetic maps. Ask students to map chromosomes using crossover frequencies. These exercises can be fun if coupled with actual experimental data used by T. H. Morgan.

3. Demonstrate the discovery of salivary chromosomes in Drosophila melanogaster. Elicit the facts relating to chromosome banding. Discuss Morgan's fly squad.

4. Discuss paternity suits and baby-switch problems in genetic cases in court.

5. Use poppet beads to demonstrate linkage and crossing over.

6. Have class read a translation of Mendel's paper. Discuss changes that can affect his work and reports.

7. Have students experiment with heredity of guppies. Blond and golden are alleles of the wild type and illustrate Mendel's laws. Platys-unspotted (recessive) and spotted (dominant) can be studied. Express results using the chi-square technique.

Nota bene: Under no circumstances should the skin of students be punctured by teachers for purposes of obtaining blood samples for typing in biology class. (From Science Safety, 1983)

Model Lesson Plan: *Mutations*

Theme: Changes in hereditary material that affect sex cells may be transmitted from one generation to another. Gene and chromosome mutations affect survival.

Aim: How do changes occur in genetic material?

Performance Objectives: Students will be able to

- relate changes in hereditary material to the structure and function of living organisms.
- relate environmental affects upon genetic material to their own life situation.

Motivation: Bring in articles showing pictures of Hiroshima, Agent Orange spraying, and mustard gas used in Afghanistan. Distribute copies and discuss in class the effects on humans. Relate Lysenko, Darwin, and Lamarck to these discussions.

Activities

1. Ask students to make a study of the environment in their home and community. Ask them to list possible causes for concern related to their own reproductive and hereditary mechanisms. Ask them to describe conditions that affect their health and how improvements can be made.

2. Discuss agricultural innovations of Luther Burbank. Show pictures of giant zinnias, polyploid watermelons. Elicit the mechanisms involved.

3. Discuss legal cases of Olympic athletes that relate to chromosome aberrations. Discuss chromosome tests used for athletes.

4. Discuss Down's syndrome, Klinefelter's syndrome, and other cases by utilizing pictures of affected humans.

5. Grow irradiated seeds and compare to nonirradiated forms. Discuss affect of x-rays used by Muller. Elicit concepts of cancer therapy using radiation. Discuss sun's rays effect on skin.

Model Lesson Plan: *Genetic Applications to Animal and Plant Bree*

Theme: Many experiments in agriculture were performed to improve the activity and to increase the survivability of desired organisms. Now procedures such as surrogate parents in cattle, cloning, cell fusion, and recombinant DNA, have shown exciting developments in this field.

Aim: How have scientists improved the genetic make-up of organisms?

Performance Objectives: Students will be able to

- describe classic experiments used by scientists.
- relate genetic theory to practical applications of genetic experiments in agriculture.

Motivation: Display modern hybrid corn cobs and earlier varieties. Show pictures of horned steers, hornless, and Brahman varieties. Ask students to compare those varieties and comment progress made in agriculture.

Activities

1. Visit a kennel, arboretum, florist shop, horse farm (race track). Have students discuss animal and plant breeding. (Plan substitute visit or have visitors come from a school specializing in agriculture.)

2. Distribute copies of New York Times science articles, or the 1976 National Geographic (vol. 150, no. 3) article on plant cloning. Discuss the new genetics as it appears to improve food quality and quantity.

Model Lesson Plan: *Interaction of Heredity and Environment*

Theme: Genes provide the potential for the heredity of cells and organisms. Interaction with the environment provides for the balance of influence in the expression of traits and the performance of the life functions.

Aim: Do all organisms live up to their potential?

Performance Objectives: Students will be able to

. correlate the factors in the environment that influence the expression of genes.
. be able to give examples of environmental interaction in living organisms.

Motivation: Display a sample of hybrid sorghum plants with a three-to-one ratio of green to albino plants. Ask what determined these traits. Expose plants to light and ask what would happen to albino plants. Ask what would happen to plants if the whole container was kept in the dark. Display second tub of plants with same ratio of green to albino and ask students to explain the results. Discuss gene function and environmental influence.

Activities

1. Discuss experiments with Himalayan rabbits. Show pictures or obtain living examples.

2. Show copies of news articles on studies of orphaned identical twins.

3. Show pictures of instinctual behavior in

termite nest building (Scientific American)
spider behavior (Nova film, "Life on a Silken Thread")

Ask students to list arguments for nature versus nature in man compared to these animals.

4. Ask students to use several coleus plants made from identical plants (cuttings) and place samples in varying light conditions. Ask them to find similar examples of conditions around their school grounds.

5. Hydrangea plants grown in different environments where pH changes from acid to base, will change flower color. Demonstrate this with several plants. Attempt to reverse the color change.

6. Grow seedlings in light and dark. Have students observe chlorophyll production in each group.

Model Lesson Plan: *Human Heredity*

Theme: Human heredity studies have been limited by ethical considerations and the difficulty in performing longitudinal studies. Modern clinical techniques have assisted many individuals and the field of genetic counseling has assisted many couples seeking information.

Aim: How can scientists detect genetic disorders?

Performance Objectives: Students will be able to

- describe the technique of karyotyping and give examples of its use in detecting Down's syndrome and other disorders.
- diagnose genetic disorders.
- describe amniocentesis and give examples for its use in genetic counseling for diseases such as Down's syndrome, phenylketonuria, and sickle cell anemia.

Motivation: Display pictures of human karyotypes. Elicit the techniques used to prepare them and discuss their use in genetic counseling.

Activities

1. Distribute pamphlets obtained from various foundations describing genetic counseling and scientific techniques.

2. Obtain films from such foundations as Sickle Cell Disease Foundation and the March of Dimes. Use selected films to demonstrate genetic counseling techniques.

3. Collect New York Times science articles on these topics and distribute them to the class for research reports.

Model Lesson Plan: *Modern Genetics — Lesson One*

Theme: DNA structure and function have been studied for many years. Recent developments in recombinant DNA research has demonstrated man's ability to restructure this molecule and insert it into certain organisms. The development of this technique reflects advances in science from identification of structure to explanation of functions which may allow restructuring genes for the improvement of society.

Aim: How was the structure of DNA discovered?

Performance Objectives: Students will be able to

. trace the discovery of the structure of DNA and the application of this knowledge to determining DNA's function in cells.

Motivation: Using a model of DNA, read portions of Watson's book, The Double Helix. Ask students to comment on the implications of the research in the 1950s and 1980s.

Activities

1. Using paper chromatography, demonstrate the identification of pyrimidine and purine bases.

2. Use the neurospora mold to grow normal and irradiated specimens (Biological Science Curriculum Study, 1961, blue version, pages 53-60).

3. Use magnetic models or transparencies to develop the concepts of protein structure and cell synthesis. Compare the process to communication of cells.

Model Lesson Plan: *Modern Genetics — Lesson Two*

Aim: How does DNA control cell activities?

Performance Objectives: Students will be able to

. relate DNA structure to protein synthesis and cell division.

Motivation: Play the telephone game by asking students to relay a detailed message from one to another (use 10 students). Elicit the problems of class communication and ask how this can be applied to cell communication. Elicit the possible problems with cells, e.g., cancer, if communication is faulty.

Activities

1. Use models and magnetic DNA templates to demonstrate duplication and protein synthesis. Compare the codes to a telegram Morse code.

2. Distribute copies of Scientific American articles describing genetic activity. Demonstrate operon theory of Jacob and Mounod by using a large slide rule (physics and math departments have these models; paper ones can be built). The movement of the slide rule can demonstrate the functioning of DNA in protein synthesis.

3. J.B. Gurdon's experiments in cloning can be demonstrated using pictures from the 1976 National Geographic (vol. 150, no. 3) article "The New Biology."

4. Discuss the founder principle of six finger traits in the Amish populations.

5. Hemophilia studies using a pedigree chart of the royal families in 19th century Europe can demonstrate gene action. Ask students to prepare their own family pedigree charts for three traits. Discussion of the experimental data gathering and explanation of the results are usually exciting for the class.

Unit VI: Evolution

Suggested time: 15 to 21 days

Unit Theme: Ample scientific evidence exists that life forms today are vastly different from those that preceded them. The identical process that assures continuation of species (genetic inheritance) is also involved in providing inheritance of change that eventually leads to the development of new species.

Evolutional theory is presented in terms of recognition of scientific evidence: zoologic record, comparative cytology, comparative biochemistry, comparative anatomy, and embryology.

Diversification among living organisms is investigated by comparing the theories of Lamarck and Darwin and contrasting both in view of modern evolutional theory based on genetics.

While the essentials of evolution, e.g., genetic change, is generally accepted, the time frame causes much discussion. Diverse thoughts, gradualism versus punctuated equilibrium, are contrasted. The heterotroph-autotroph hypothesis attempts to explain and relate modern understandings in genetics with a hypothesized series of events that may have led to the development of a living organism. Evidence is based on interpolation of known information (chemical bonds associating to form synthetic organisms) with a basic assumption of the conditions existing in the primitive earth.

Topic 1: *Evolution*

Topic 2: *Evolutional Theory*

Suggested Time 12-15 days)

Topic Theme: This course of study explores a variety of theories and scientific observations in an attempt to explain the differences and similarities among life forms.

Borrowing evidence from the geologist, cytologist, biochemist, anatomist and embryologist, a conclusion is drawn in regard to the history of life on earth.

Theories of evolution (Lamarck, Darwin, and genetic basis) are taught and evaluated in terms of relating their concepts with observable phenomenon. The syllabus emphasizes that the topic should be discussed in terms of scientific theory and not as unchanging dogma.

Teaching Strategies: *An Overview*

Redefine for your students the difference between theory and law in science. Provide evidence for the theory of evolution objectively, permitting students to question the efficacy of each category. Utilizing the evidence developed in your introduction, introduce the contrasting theories of Lamarck and Darwin. Theories should be presented in relation to the time they were presented and the beliefs held by individuals. Demonstrate how advances in genetics and biochemistry have permitted us to redefine and further elaborate on theories of the past. Infer that further refinement will be possible as technological advances permit us to explain our past and predict the future.

Teaching Strategies: *Sequential*

1. Distinguish between the terms theory and law as a basis for introducing the evolutional theory. Display pictures or models of animals or plants that are extinct; compare their structures with animals and plants that are alive today. Students should relate their learnings in genetics to explain how organisms are capable of change. Allow them to hypothesize why some living organisms become extinct while others continue to survive. (Display horseshoe crab.)

2. The supporting observations or evidence for evolution may be established by providing concrete evidence and allowing students to relate the evidence to the theory of evolution. For instance, observing fossil remains leads to an explanation of how fossils are formed. The fossil record then provides direction to the establishment of a scientific picture related to the phylogenetic development of the organisms. (Suggestion: Ample supplies may be provided from the physical science department's earth science offering.) The sequence established in the syllabus is quite logical. Provide activities as listed in the activities sections.

3. Evolution provides a unifying opportunity for the teacher in terms of bringing together concepts previously learned, e.g., comparative cytology, biochemistry, anatomy, and embryology.

4. The explanation provided for the giraffe's long neck is standard when comparing Lamarck's and Darwin's theories. Ample illustrations are available and should be provided as each aspect of the widely divergent theories is presented. Provide other examples to complement the theory and provide further basis for class discussion.

5. Darwin's theory was primarily inductive and provided little scientific support other than observation. At this time, review some of the concepts in genetics and relate them to the various parts of Darwin's theory. For instance, "the genetic basis for variation within a species is provided by mutations and sexual reproduction." Be liberal in your use of examples, e.g., insect resistance in response to insecticides.

6. Geographic isolation and reproductive isolation, if taught without specific examples, will not be completely understood. The Galapagos Island chain, with its concomitant variety of animals, are excellent examples for this section. Most texts have adequate illustrations.

7. Modern evolutional theory places the time frame for evolution -- gradualism/ punctuated equilibrium -- at odds with each other. Present the concepts and allow students to share their feelings regarding which concept is most logical. Remember, their feelings should be supported by scientific evidence.

Performance Objectives

Students will be able to

- define the term evolution.
- cite evidence supporting the theory of evolution.
- explain how fossils may be used as a form of evidence for evolution.
- outline how each of the following represents supporting evidence for the theory of evolution:
  - geologic record
  - comparative cytology
  - comparative biochemistry
  - comparative anatomy
  - comparative embryology
- discuss and contrast Lamarck's and Darwin's theories of evolution.
- compare modern evolutionary theory with those proposed by Lamarck and Darwin.
- explain how modern genetics has influenced current theories of evolution.
- distinguish between geographic isolation and reproductive isolation.
- discuss and compare the two theories of evolution -- gradualism and punctuated equilibrium.

Activities

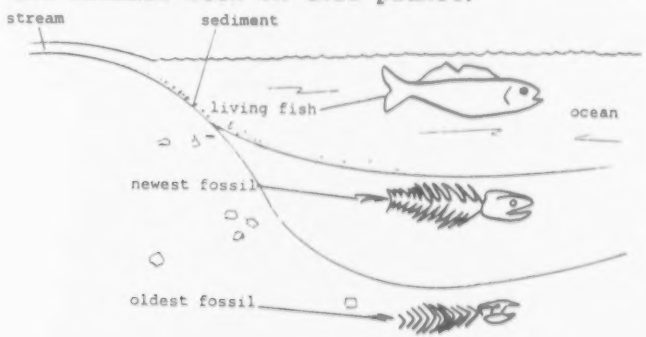
1. [D, L] Fossil display - Display a variety of fossils. Ask your students to identify some of the common features observed in each. What was the appearance of the animals or plants that resulted in the fossils? What kinds of life forms today resemble those of the past?

2. [D,L,P] Plaster of Paris model fossils - Demonstrate how an imprint fossil may be formed. A plaster of Paris cast may be made by coating a fossil with petroleum jelly. Form a border with clay, then add about one-half to three-quarters of an inch of plaster of paris. Hardening of the cast will usually result in about 20 to 30 minutes.

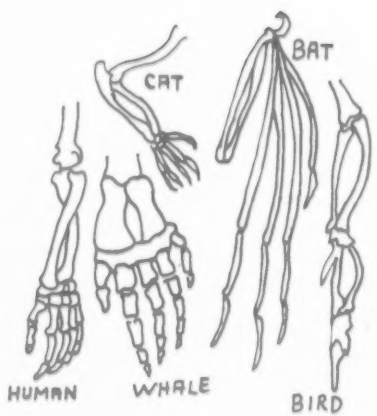
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

3. [D] Earth timetable - Display a large circle and label it "Timetable of Life on Earth." Have students divide the circle into periods and eras on earth with corresponding life terms in each. How much time (proportionately) have man and mammals been on this planet?



4. [D] Comparative skeletal structure - Dissect or display the skeletal structures of fish, frog, cat, dog, and man. Students should study the anatomical similarity among the different species.



5. [D] Comparative anatomy--animals - Similar comparisons may be made by dissecting the heart of a fish, bird, and cow. Similarities and differences are noted; relationships are established. An alternative is a comparative study of the brains of different animals.

6. [D,L] Comparative anatomy--plants - Don't permit your students to forget that plants, like animals, also have undergone evolution. Compare anatomic structures. Growing a number of monocot seeds (wheat, oats, grass, corn) simultaneously will demonstrate similarities in embryonic development.

7. [D,L] Overproduction--amphibian egg production - Overproduction may be demonstrated by having students count the number of eggs in a mass of frog or fish eggs, or the number of seeds produced by a simple dandelion. Approximate the number of seeds produced by a simple tree (maple).

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

8. [D,L] Over-production - drosophila culture - Display a drosophila culture that contains many flies, larvae and eggs. If a single female lays 300 eggs within a two-week period and if all survive, how many flies would be developed at the end of a month?

9. [D,L,P] Variation between bean seeds and eggs - Students can measure differences or variations among living things. Graphs of these findings should be displayed. Inferences for evolution should be developed. Examples: measuring the length of bean seeds, comparing the height of students in the class, or weighing two dozen eggs. Obviously the larger number of specimens used, the greater the variations.

10. [D,L,P] Competition--sod - Obtain a piece of sod one foot square. Be sure that the sample has a variety of plants (grass or weeds, such as dandelions) that are in various stages of development. Allow the sample to dry out. Which of the plants survive the best? After a period of time, water the plant. Which group of plants grows most rapidly?

11. [D,L,P] Variations--drosophila - Variations in size and characteristics can be examined and determined by observing numbers of anesthetized drosophila.

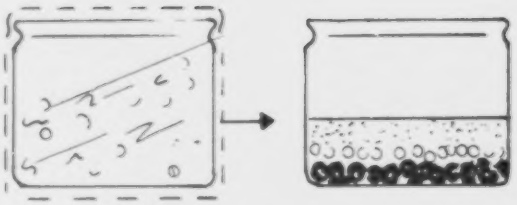
12. [D,L,P] Population--competition - Mix different varieties of drosophila (white eye, vestigial wing, wild) in a large culture container (milk bottle for example). After a period of time (two weeks), count a sampling of flies. Compare to starting population. Which group appears most successful in terms of reproduction? Why?

13. [D,L,P] Overcrowding among seedlings - Plant seeds (mustard, radish, oats, or beans) in two pots. In one pot use twice as many seeds. After a few weeks compare the growth in the two pots. Have students graph their results and explain how overcrowding affects seed survival.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

14. [D,L,P] Overcrowding among fruit fly populations - How does overcrowding affect animal survival. Prepare fruit fly medium and pour into four culture bottles and four plastic vials. Introduce four pair of fruit flies in each container. Remind students to sprinkle yeast on the surface before introducing the flies. During the next four weeks have each student record the number of offspring. Graphic representation of results, as well as photos, can aid in a discussion of the results. Ask students to relate this experiment to human population growth patterns.



15. [D,L] Sedimentation in a jar - Have students fill jars (halfway) with fine sand, coarse gravel, small rocks, humus and clay. Ask them to fill with water and shake gently. Ask them to observe and record their results. Have them discuss the implications for fossil formation in sediments.

16. [D] Peppered moth - Ask students to discuss the evolution of the peppered moth using a filmloop (Hubbard: The Peppered Moth). Pictures of the comparative forms can be viewed in the Biological Science Curriculum Study yellow version (Harcourt, Brace and World, 1963).

17. [D,L,P] Protective coloration - Protective coloration or shape (twig - walking stick; monarch butterfly - viceroy; snowshoe rabbits have winter coloration) may be used to permit students to conclude how those features aid in the organisms' survival.

18. [D,L,P] Carrying capacity--drosophila / seedlings - Competition among drosophila, seedlings, protozoa can be demonstrated by placing numbers of these organisms beyond the carrying capacity of the culture containers. For example, assume that a six-inch pot can appropriately conform to the growth of two seedlings of a known species. Place 10 to 20 seeds in the pot. Why do some survive?

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

19. [D,L,P] Adaptation - bacteria - Evolution in bacteria can be observed by purposefully culturing resistant strains of bacteria observed from cultures treated with various antibiotics. Extreme care must be taken; all bacteria are potentially harmful. (Why?)

20. [D,P,R] Museum of Natural History - A trip to the Museum of Natural History is ideally planned for this section. Officials at the facility can arrange for a guided tour geared to a specific topic, e.g., dinosaurs or the evolution of man.

21. [D] Biochemical comparison - Refer to production of insulin from pigs for use in human diabetics. Display labels from empty packaging where references are made to animals used for production process. Similarities in biochemical compounds may be emphasized at this point.

22. [D] Fossils--Museum - Fossil finds are best illustrated through a visit to the Hall of Dinosaurs at the Museum of Natural History.

23. [D] Protective coloration--polar versus brown bear - Display pictures of the brown bear and polar bear. Ask students to describe how environmental conditions select certain characteristics in organisms.

24. [D,L,P] Soil screen selections - Soil screens are excellent ways of demonstrating how the environment is capable of selecting for a special characteristic, e.g., size.

25. [D] Irradiated seeds--mutation - Irradiated seeds are commercially available. Germinate and compare with normal seeds.

26. [D] Leaf structure--comparative anatomy - Display leaf structure from a variety of plants. How is each adapted to its environment? What changes in the environment would select one over the other?

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 3: *Heterotroph Hypothesis*

Suggested time: 3 to 6 days

Topic Theme: Based on the assumption that early earth had an atmosphere of certain composition and that specific conditions regarding energy forms existed, a hypothesis evolves on how the first forms of life may have developed. Aspects of the theory following the basic assumptions are logical and scientifically sound. The heterotroph hypothesis unites many of the concepts taught in previous chapters and provides a concrete basis for explaining the origin of life.

Teaching Strategies: *An Overview*

The origin of life on earth parallels the philosophical theories with the origin of the universe. The heterotroph hypothesis is an attempt to provide a degree of understanding of events that occurred billions of years before the appearance of the simplest form of life. Distinguish between a theory and a hypothesis, allowing students to recognize that we spoke of Darwin's theory of evolution but returned to the origin of life as the heterotroph hypothesis. Other hypotheses: gradualism and punctuated equilibrium can be reviewed once more within the purview of the understandings developed with the heterotroph hypothesis. An interesting postinstruction activity may be to permit students to present their own hypotheses and evaluate them with present scientific thinking.

Teaching Strategies: *Sequential*

1. Review the cell theory establishing the problem that, although existing life today came from preexisting life in the past, the question as to the first form of life still has not been answered. Explain to your students that no living organisms could have existed in primordial earth because of the tremendous temperatures and instability.

2. Provide a diagramatic representation of primitive earth characteristics assumed to be evident during this early period. Establish a relationship between the raw materials in the atmosphere, their chemical composition, and the structural formulae for common organic compounds. Recall that chemical reactions require a source of energy, and that energy in the form of heat, ultraviolet and cosmic radiation, as well as lightening (electrical), were readily available for these chemicals to react.

3. An excellent opportunity exists at this time to review modes of nutrition (heterotroph/autotroph) and modes of respiration (anaerobe/aerobe). Allow your students to describe the type of nutrition and respiration characteristics of the first living organism.

4. The student should logically explain why heterotrophic/anaerobes must have come into existence before autotrophic/aerobes. Finally, compare the characteristics of living organisms today with those that may have existed during primitive times.

5. As indicated in the syllabus, this topic should be taught as theory rather than as unchanging dogma. Indeed, the possibility of an oxidizing atmosphere and gradualism versus punctuated equilibrium shows how the thoughts of scientists diverge.

Performance Objectives

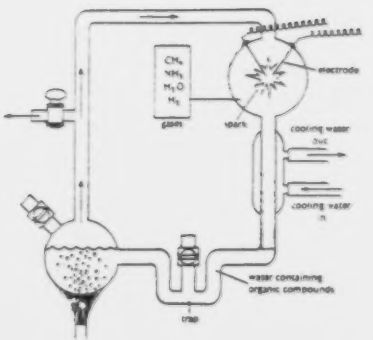
Students will be able to

- summarize the sequence of events described in the heterotroph hypothesis.
- explain how organisms evolved from heterotroph to autotroph and from anaerobe to aerobe.

Activities

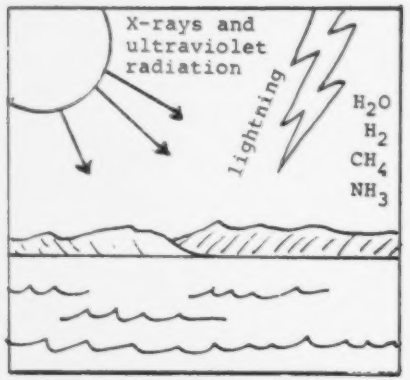
1. [D] Raw material--origin of life - Display vials with white powder, liquids and gases. Label the vials amino acids, carbon, hydrogen, oxygen, phosphorus, sulfer, carbohydrates and fats. (Note: Contents of vials are not important; labels are and should be clearly displayed.) Challenge your students to combine the substances, all of which are found in living organisms to create life.

2. [D,L] Coacervate demonstration - Coacervate demonstration: A grouping together of proteins, carbohydrates and other materials into organized droplets is called a coacervation. Coacervates exhibit some properties of living things. It is hypothesized that such droplets might have been an important step in the origin of life. Mix together 5 ml of gelatin (protein) solution and 3 ml of gum graphic (carbohydrate) solution. Place a drop on a slide and observe. Add one drop at a time of .1 m HCl; measure the pH and observe. Continue until solution turns cloudy. Note: Acidification must be accomplished slowly. Compare a slide of living amoeba with the organization of coacorvates.

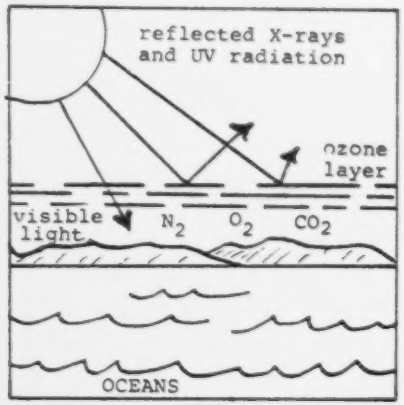


Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

3. [D] Energy and the heterotroph hypothesis - Use a tesla coil, radiometer and radioactive detector (Geiger counter) to illustrate energy sources available on the earth. Ask students to determine the possible effects of energy.



4. [D,R] Radioactivity and half life - Display and use a Geiger counter. Discuss the use of radioactive dating and the calculation of half life. The effects of the long-lived isotopes on environment and organic evolution should be discussed. Nuclear waste can be discussed in relation to recent discoveries in the news.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Model Lesson Plan

Aim: What is the scientific evidence that supports the theory of evolution?

Performance Objectives: Students will be able to:

. define the concept of evolution.
. cite scientific evidence in support of the theory of evolution.
. justify the concept of evolution in terms of the evidence.

Motivation: Distribute fossil materials. (It is desirable for each student to have his/her own sample.) Ask each student to describe the kind of organism that was fossilized. Are there organisms alive today that resemble the fossil organism? How would they be similar? How different?

Concept: Evolution is a process of change through time.

Development

1. Place some seashells into a gallon container filled with water and about two inches of sand. Now add gravel, sand, or other sediment. Observe what happens to the shell. Relate to fossil structure.

   Concept: Fossils are the remains of organisms preserved in sedimentary rock, amber, ice, or tar.

2. Place a raisin or peanut in an ice cube tray, fill with water, and allow to harden overnight. How does ice preserve the structure of organisms? Why didn't the organism decay? (Review previous learnings on enzymes, their inactivity at low temperatures; and absence of air.)

3. Demonstrate the preparation of plaster prints of leaves, shells, foot-prints. Compare them with the fossils distributed earlier in the period. What conclusions can be drawn from this observation?

   Concept: Fossils may be indirect remains, i.e., imprints of organisms.

4. Pour three samples of different colored sand into a large container. Which layer is the oldest? Compare this demonstration to the rock strata observed in the Grand Canyon (show pictures). What can you conclude about fossils found in the lowest layers compared to those found higher up?

   Concept: In undisturbed strata, generally the fossils of life forms in the lowest strata represent earlier life forms than those of the upper strata.

Application: Place each of the following animals in the order in which they may be found as fossils in rock strata: blue-green algae, dinosaurs, bony fish, seashells, marine worms, saber-tooth tiger.

Justify your selection. How would an earthquake or mountain building process affect the inferences that may be derived from fossils in regard to the evolution of life?

Unit VII: Ecology

Pages 118 to 135

Suggested time: 15 to 22 days

Unit Theme: The unifying aspects of this section should be emphasized. Students have surveyed living systems and are now ready to be provided with an appreciation and respect for life.

The interrelationship between the living and the nonliving environment are clearly established throughout the unit.

The cycling of material through living organisms permits an opportunity to combine understanding of science with a sense of social responsibility.

Although the vocabulary and concept density in this unit are high, the terms appear much more concrete and palatable to students. Using the school community or organizing field trips to parks or zoos makes the understandings even more concrete. The term's work culminates in the discussion of ethical considerations, such as population growth and land management.

Teachers should attempt to provide adequate time for this unit. Experience has shown us that the concepts remembered for the longest time are those that may be gleaned from this topic.

Topic 1: *Ecology*

Topic 2: *Ecological Organization*

Suggested time: 2 to 4 days

Topic Theme: The relationships of living things to their environment has many subdivisions. Living things interact as populations of the same species. When populations interact, plants and animals are part of an increasingly complex web of interrelationships. The beauty of these topics lies in the simplicity as well as the complexity of these interrelationships. Ultimately, the habitable portion of our planet, the biosphere, represents the total sum of all these interactions. The wonderment associated with life on our planet has been expressed by astronauts, cosmonauts and all who have vicariously viewed our planet from space.

Teaching Strategies: *An Overview*

Most of the activities suggested in this unit overlap the content and may be used in a variety of topics and lessons. It is advisable to vary the activities so that students learn related concepts while experiencing different examples.

The world is the classroom. Allow the student to learn the topic by experiencing it within his/her community. Provide opportunities for surveys, student reports, panel discussions. Utilize news media reports both to enliven and to contemporize the subject.

Although the unit contains an incredible number of terms, the content will be more easily understood as it relates to the immediate environment.

Teaching Strategies: *Sequential*

1. Ask your students to define ecology. The discussion soon reveals that the study of ecology is the study of the world in which we live. The students should be made to realize that no living organism exists as an entity, separate from other living organisms and the environment.

2. Display a globe. Have your students suggest what percentage of the earth is capable of providing environs for living organisms. The fragility of this balance can be appreciated by explaining to your students that the biosphere is equivalent to the thickness of an eggshell.

3. Distribute pictures of forests, deserts or other major biomes. Students should list as many living organisms as visible and also the major features of the abiotic environment. You can now establish the hierarchy of ecological organization listed in the syllabus.

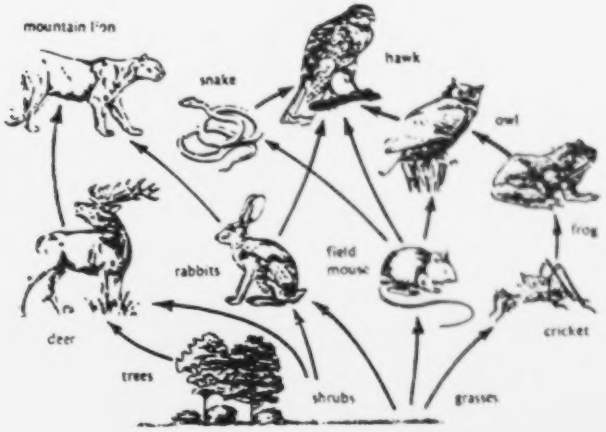
Performance Objectives

Students will be able to

. define the study of ecology.
. define and distinguish between the terms population, community, ecosystem.

Activities

1. [D,L,P] Microscopic examination of pond water - Distribute a drop of pond water (or grow in advance a rich culture of mixed protozoa and algae). Ask your students to list as many living and nonliving things as they can observe. Diagrams are helpful and useful. How are the organisms related to one another?

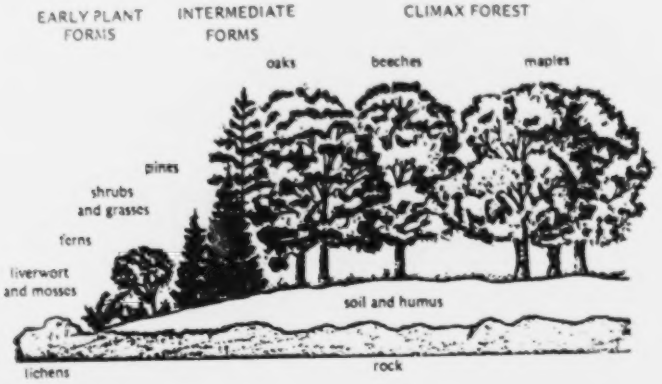


Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

2. [D] Ecosystems - The number of films, filmstrips, and video tapes on this topic appear to be endless. Teachers should review each carefully and select those that permit instruction of new topics rather than repeating the same concept. Time will be a deciding factor, as a great deal is covered in this unit.

3. [D,L] Local ecosystem - Visit a local vacant lot. Have students illustrate or describe various stages of succession. If this is not convenient, provide pictures or slides to demonstrate similar conditions.



4. [D,L,P] Terrarium or herbarium - Construct a terrariam or herbarium to represent different stages of ecological succession.

5. [D,L,P] Comparison: Soil composition--soy versus bean - Observe the nodules in soybean plants; illustrate cross section and role of nitrogen-fixing bacteria. Grow bean seeds in soil that soybeans grew in; compare their growth with those grown in loamy soil mixture.

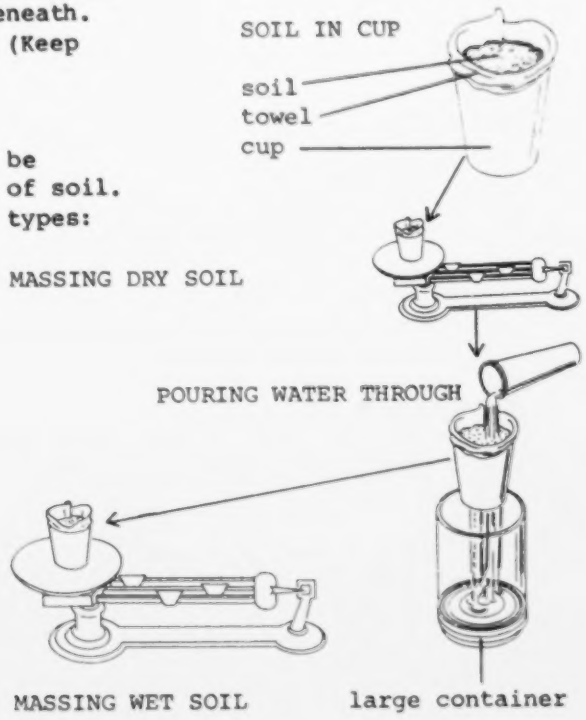
Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

6. [D,L,P] Growth of plants--variable water - Compare growth of plants that have been given varying amounts of water. Be sure to vary the amount of water (soil, plant, and exposure to sun should be constant).

7. [D,L] Bullfrog dissection - Dissect a preserved frog. (Bullfrogs are best for this demonstration.) Empty the contents of its stomach. Try to identify the various organisms that it has eaten. Develop a food chain or web.

8. [D,L,P] Lichen growth - Students should examine a rock on which lichens are growing. Scrape off a bit of the lichen and examine the rock beneath. Place some of the lichen into a terrarium. They should grow well. (Keep terrarium or spot where grown on the dry side.)

9. [D,L] Water-holding capacity - Soil water-holding capacity can be demonstrated by placing a measured amount of water in various types of soil. Water should be collected in a beaker and measured. Suggested soil types: humus, sand, loam.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

10. [D] Field trip - Conduct a field trip to record, collect, and survey an area around your school community. Collecting material for a terrarium or herbarium is useful.

11. [D,L] Soil-building activity - Students can learn how soil is made by rubbing a piece of sandstone and limestone together. Note the fine particles that are deposited.

Safety Glasses

Fire

12. [D] Effect of rapid cooling on weathering of rock - Heat a piece of limestone and quickly drop it into a pan of ice water. The rock should break or crack, showing the effect of weathering.

13. [D,L,P] Soil sample profile - A profile of soil may be made by placing a spade 2 to 3 feet into the ground and examining the layers. A hollow pipe 2 to 3 inches in diameter will also achieve a desirable effect.

14. [D] World biomes - Maps and globes may be used to demonstrate location of major biomes. Try to obtain appropriate pictures of areas being studied.

TUNDRA

TAIGA

15. [D] Water cycle - Evaporate water in a beaker. Place a glass plate on the beaker; observe condensation process.

16. [D] Analysis--fertilizer content - Display a bag of commercial fertilizer. Have students analyze contents and relate to biogeochemical cycles and biotic needs.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Topic 3: *Ecosystems*

Pages 119 to 124

Suggested time: 4 to 6 days

Topic Theme: The beauty and simplicity of the relationships in nature are readily available at every level. The study of the biotic and abiotic factors includes the ecosystem as the basic unit of structure. The ecosystem involves the unique relationships of living things and their environment in a microcosmic unit.

Teaching Strategies: *An Overview*

As presented in the syllabus, much of this topic is "extended." The authors feel that this mode is regrettable, as some of the most vital aspects of ecology, and indeed some of the most interesting, will be neglected. We suggest that the teacher carefully review the entire topic and the teaching strategies, and select aspects of each extended unit that will enhance the teaching/learning process.

Teaching Strategies: *Sequential*

1. A balanced aquarium or terrarium will help the instructor develop an understanding of the ecosystem.

2. Be liberal in the use of pictures, models, and other visuals to demonstrate the concepts being developed in this unit. For instance, simply defining herbivores or carnivores is not as effective as displaying a model or picture of each. The use of field trips, e.g., the zoo, is ideal but can only be done if the teacher provides adequate time to complete this unit.

3. (Extended) Most students are not aware of symbiotic relationships and will find the dialogue established in this section very interesting. Provide as many examples as possible so that students appreciate how frequently and universally symbiosis occurs.

4. Energy flow is a strange, often uncomfortable term for students. However, establishing a food chain, then a food web, is quite easily achieved. Convert a food chain to a pyramid of biomass. With striking similarity the pyramid of biomass can be equated with a pyramid of energy. Although the biomass pyramid is listed as an extended optional, its inclusion at this point is a requirement that should not be overlooked or missed.

5. A feature prevalent in ecology is the concept that material, once used, should be recycled. The decay process returns raw materials to our environment for use by other living organisms or biogeochemical processes. Cycles are best presented in a format that follows the flow-chart model. Begin at a point that is logically developed by your students, e.g., exhaling carbon dioxide, develop the use for carbon dioxide and finally return to the starting point. Students should learn to design, interpret and comment on flow charts developed.

6. (Extended) The nitrogen cycle is the most complex presented. Students should recognize the need for nitrogen in the formation of proteins and obtain an understanding that only plants are capable of converting from nitrogen and nitrogen compounds into amino acids and proteins. Once established, the flow chart can be further embellished.

7. Students should relate their experience observing what happens to a lot once the trees and houses have been removed. Most will relate to the appearance of simple vegetation (moss, grasses). Ask them to suggest how the appearance of that lot will change in 50 to 100 years. Lead to the definition of the term "succession."

8. (Extended) Trace the succession (fauna and flora) listing pioneer plants and, wherever possible, index animals in an environment such as bare rock or sand. Emphasize that organisms initially occupying an area prepare the environment in that area for the next group of usually more advanced or complex animals and plants. Finally, the climax community (self-perpetuating, stable community) is reached. List typical climax communities found in our area: oak-hickory and hemlock-beech-maple are two examples.

9. (Extended) The term biome should have been previously defined. Display wall charts and globes to reflect the various biomes apparent on the earth. Without identifying the biomes by name, ask your students to suggest where they might expect to find each of the following: conifers, succulents, and deciduous trees. They will recognize that the locations of these flora are restricted to certain sections of the earth and are characteristic locations of the terrestrial biomes listed in the syllabus.

10. (Extended) Take your students on an imaginary trip up a mountain. Ask them to compare the types of fauna and flora found as the altitude increases, and identify the living organisms found with latitude. Develop the chart comparison found in the syllabus.

11. (Extended) Aquatic biomes, marine and fresh water can be established in much the same way as the terrestrial biomes. In this section it is vitally important for students to appreciate the differences in fresh and marine water environments, while recognizing the effect of each on terrestrial biomes, e.g., stabilizing factor for temperature.

A. Ecosystem Structure and Function

Suggested time: 4 to 6 days

Performance Objectives

Students will be able to

- list and relate the abiotic and biotic components of an ecosystem.
- explain how each abiotic factor represents a "limiting factor" in the ecosystem.
- compare autotrophs and heterotrophs.
- distinguish between saprophytes, herbivores, carnivores and omnivores.
- provide an example for each type of symbiosis.
- describe the flow of energy and biomass in a food web.
- (Extended) diagram and explain a biomass pyramid.
- summarize the following geochemical cycles: carbon-hydrogen, water, nitrogen
- (Extended) illustrate a flow chart on the nitrogen cycle.

B. Ecosystem Formation

Suggested time: 4 to 6 days

Performance Objectives

Students will be able to

- describe the process of ecological succession and provide an example of each stage.
- (extended) summarize and illustrate the stages of succession beginning with pioneer organisms to climax community.
- (extended) provide examples of ecological succession in New York State.
- define the term biome.
- (extended) describe the characteristics and climax flora and fauna of the following biomes: tundra, taiga, temperate deciduous trees, tropical forest, grassland and desert.
- relate ecological succession with latitude and altitude.
- (extended) diagram a chart relating ecological succession with latitude and altitude.
- (extended) compare the characteristics of aquatic biomes: marine and fresh water.

Activities

1. [D,L,P] Effect of light and inorganic minerals on plant growth - The need for light and inorganic minerals may be demonstrated by placing in separate pots similar plants, under different lighting, and subject to different watering or soils of various mineral content. A mixed flat reflects competition among species under the conditions outlined.

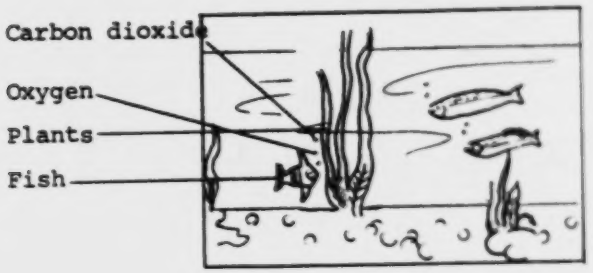
2. [D] Terrarium-herbarium - Construct terraria or herbaria that illustrate moist conditions, deserts, and those of moderate humidities. Stock the setups with flora and fauna reflective of the conditions being studied. What special adaptations were required for each setup?

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

3. [D] Balanced aquarium - A balanced aquarium (use live plants, not a pump) can be compared to the sensitivity of our biosphere. Why do plant stores use air pumps, heating devices and elaborate filtering apparatus?

BALANCED AQUARIUM

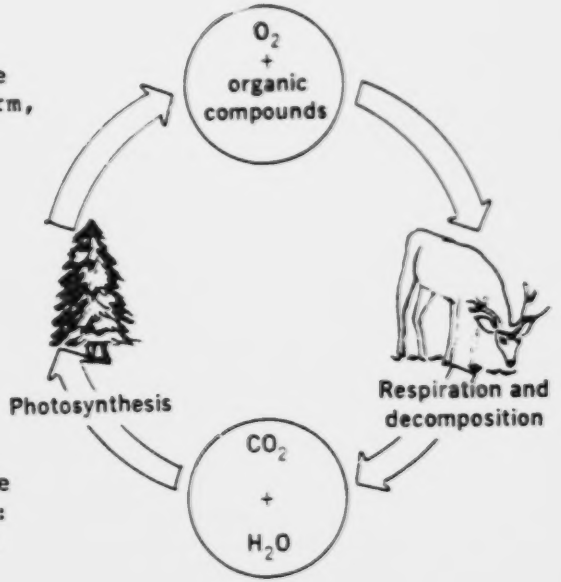


4. [D] Symbiosis - Symbiotic relationships can be demonstrated through the use of pictures and actual specimens. Most schools have samples of tapeworm, barnacles, and lichens.

5. [D,P] Charting - biogeochemical cycles - Exhibit diagrams of biogeochemical cycles: carbon, water, and phosphorous.

6. [D,L,P] Pond water succession - Add pond water to a hay infusion. A succession of species will be observed. Students observe and record the succession of dominant species.

7. [D,L,P] Microaquatic biomes - Class sets of microaquatic biomes can be prepared and distributed to an entire class at minimum expense. Materials: test tube, stopper, elodea, snail. Groups of students can vary essential ingredients required for growth, e.g., light and temperature.



Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

8. [D,P] Marine and fresh water aquaria - Maintain salt water (marine) and fresh water aquaria. Students should record and observe relative difficulty in setting up and maintaining each setup, and adaptations of fish for survival in each.

9. [D,L,P] Water pollution--coliform - Demonstrate the techniques for testing pollution levels in water. Escherichia coli is a standard marker for human waste contamination.

10. [D] Field trip--ecosystems - A field trip to Alley Pond Environmental Council (APEC), the Jamaica Bay Wildlife Preserve, or Riis Park (permit required) will enliven this subject in a manner that cannot be duplicated with straight textbook material.

11. [D,L,P] Mutualism - On a class field trip around the school, students can collect some clover. The nodules of the roots of these plants contain nitrogen fixing bacteria. These nodules can be crushed and stained with methylene blue.

12. [P] Insectivorous plants - Set up a terrarium with pitcher plants, sundew, and Venus's flytrap. Introduce fruit flies into the terrarium and ask students to view the results. An additional box to allow a platform for the aquarium may be needed for visibility. A moveable cart can be used to allow for greater visibility.

13. [D] Plant parasites - Bring into class examples of dodder (Cuscuta gronovui), a plant parasite. The structures of this plant resemble a vine. These structures (haustoria) of the dodder actually grow into the host plant and utilize the nutrients.

Key: D - demonstration, L - laboratory lesson, R - report, S - speaker, P - project

Topic 4: *Biosphere and Humans and the Future*

Suggested time: 5 to 6 days

Theme: The unique role of humans in the general scheme of the biosphere is discussed. The role of humans, often considered separate from other co-inhabitants of the planet, is discussed. Special emphasis is placed on our unique responsibilities and our powerful influence on the physical and living world. One astronaut recently observed that the earth's color was blue 10 years ago when he first viewed it. Ten years later he described the color as grey. The change, in such a short time, exposes the danger of our neglect of the careful maintenance of the biotic and abiotic factors that sustain our planet and us.

Teaching Strategies: *An Overview*

Practically all the technical terms have been taught previously. At this time you should direct the students to apply their understanding toward realization of man's affect on his environment. Direct the student to hypothesize or suggest solutions to each problem. Do not neglect the positive aspects. Concentrate on how we can assure continuance or expansion.

Teaching Strategies: *Sequential*

1. The negative aspects of man's influence on his environment has been so well documented that students have little difficulty finding news articles on this topic. Practically every item listed in the syllabus may be covered through student reports, current events, and pamphlets distributed by various interest groups. As suggested in the syllabus, the use of local examples is encouraged.

2. The positive aspects of man's influence on his environment have been basically corrective in nature. For instance, conservation of resources did not become an issue until certain raw materials were in short supply. Suggestions offered in the activities section suggest useful demonstrations and activities for this topic.

3. A fitting conclusion for this course is to have students predict or hypothesize as to their future and the future of all living things on earth. They may list the steps that should be taken to assure our survival, while condemning prevalent practices that may lead to the demise of living organisms.

Performance Objectives

Students will be able to

- list the negative aspects of man's effect on his biome.
- identify the problem and propose a solution: human population growth, overhunting, importation of organisms, exploitation, poor land-use management.
- describe the factors leading to water and air pollution.
- explain how chemical waste disposal problems provide pollutants in our environment.
- list and summarize the aspects of man's control of his environment.
- hypothesize as to the ecological future of our planet.

Activities

1. [D] Endangered species - Distribute a partial listing of animals that are endangered or extinct. The Bronx Zoo will gladly supply you with this listing. Do not place a heading on the listing. Ask students to determine a relationship between the organisms listed. What role did man play in the situation demonstrated in the listing?

2. [D] Environmental problems - Make a collection of articles that are concerned with environmental issues. Students can collect 10 to 20 articles within two weeks with little effort. Have them summarize the topics being discussed, problems expressed and solutions proposed.

3. [D] Urban environment - Ask a member of the Environmental Protection Agency to speak to your students. Explain the function of this agency and some of the urban problems they are dealing with.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Activities (continued)

4. [D,P] Ecology and legislation - Have your students create an ecological law that they feel should be passed by their legislator.

5. [D] The future - Assign your students an essay topic: How do you visualize the world in which you now live in the year 2000? Why?

6. [D] Current laws - Copies of state and federal laws may be distributed for review and analysis. What are the problems concerned with implementation?

7. [D] An extinct species - Students can research the story of the passenger pigeon. Emphasis should be on the role man played in the extinction of this species.

8. [D,P] Readings - Rachel Carson's Silent Spring is an excellent publication that may be assigned either for extra credit or as a class project.

9. [D] Posters - Weyerhauser Lumber or agencies associated with the Department of Agriculture supply posters showing the principles of reforestation.

10. [D] Terracing - Use a chalkboard and four strips of paper toweling taped parallel to the board. Wet the area above the first paper towel strip. Ask students to observe the effect of water run-off as it passes each strip.

Key: D = demonstration, L = laboratory lesson, R = report, S = speaker, P = project

Model Lesson Plan

Aim: How has man modified his planet?

Performance Objectives: Students will be able to

. describe how activities such as overhunting, importation of organisms, exploitation and poor land use have altered the biosphere.
. interpret ecological data and forecast future events.

Motivation

Bring in a square foot of sod. Take one quarter of the sod and gently wash away the soil to expose the network of roots. Students should readily view and evaluate the role of roots in anchoring the soil.

1. What is the possible effect if forest land were cleared for housing development? For harvest of lumber?

2. List the steps you would take to prevent such events from happening.

Development

1. Man has not always been aware of the powerful influence he has had on the physical and living world.

2. Distribute a list of animals that are either extinct or endangered. (Such a list is available from the Bronx Zoo). Do not place a heading on the list. Ask your students to suggest what the list represents.

Concept: Uncontrolled hunting and fishing have resulted in extinct or endangered species. Examples include passenger pigeon, dodo bird, and blue whale.

3. Display newspaper or magazine articles and pictures showing the destruction of trees by the gypsy moth. Advertisements for insecticides and other devices to control the pest would also stimulate interest. Ask your students to explain why the gypsy moth has proved so successful in the Northeast.

   Concept: Man has on occasion introduced organisms into areas where they have no natural enemies. This has led to major disruptions of delicately balanced ecosystems. Examples are gypsy moths, Japanese beetles, and organisms that cause the Dutch elm disease.

4. Display pictures of drought conditions and overgrazed or farmed land. Present an overview or capsulation of The Grapes of Wrath. Refer back to the motivation at the start of the lesson. Conduct the water-holding capacity experiment with a variety of soil types. What do the demonstrations have in common? State a conclusion that may be derived from these observations.

   Concept: Poor land management practices have resulted in the loss of topsoil and the destruction of natural habitats further threatening the existence of wildlife species.

Application: For each negative affect that man causes the biosphere, suggest a solution that would prevent further destruction.

Homework: Construct a proposal for legislation that would prevent or curb misuse of our land, water, and air.

Laboratory Skills Section

320

GUIDE TO LABORATORY SKILLS SECTION

The exercises suggested in this section reflect the testable laboratory skills listed in the State syllabus.

Each exercise has been written in the following format:

1. Laboratory skill number and statement from the N.Y. State syllabus.

2. A title for the investigation.

3. Performance objectives rephrased from the N.Y. State syllabus.

4. A statement entitled PROBLEM (BACKGROUND) provides both teacher and student with a reading designed to motivate and/or explain the investigation.

5. An experimental procedure section contains a list of methods and in some instances suggested student worksheets.

6. Teacher's notes describing potential pitfalls, timing, and subject material that should have been covered before the lesson.

LABORATORY SKILL 1: Formulate a question or define a problem and describe a hypothesis to be tested.

INVESTIGATION: To disprove the theory of spontaneous generation.

PERFORMANCE OBJECTIVES Students will be able to:

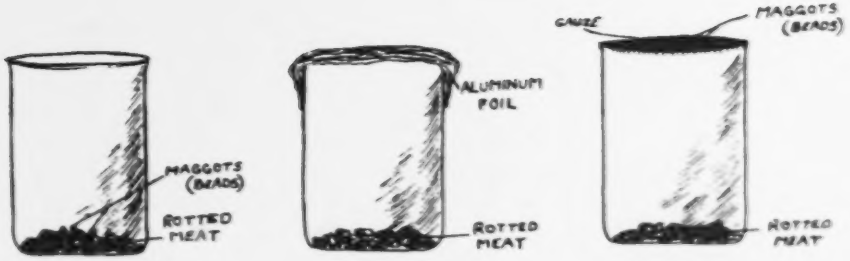
. formulate the scientific problem.
. develop a hypothesis.
. conduct an experiment that investigates the problem.

MATERIALS

glass beakers 50 ml to 100 ml
plastic wrap, aluminum foil
clay beads or balls to represent flies and eggs
large chunks of clay to represent food substances
guaze bandage material or cheesecloth cut into squares large enough to fit over the mouths of beakers
marking pencils (for glass)
rubber bands to secure material over beakers

PROBLEM (Background)

The belief that living organisms can be generated from nonliving substances is commonly referred to as "spontaneous generation". This belief was accepted in the scientific community for hundreds of years. Philosopher scientists such as Aristotle taught their disciples that a mixture of nonliving material could and did produce living things. The vitalists, a group that successfully dominated the thinking of the scientific community into the nineteenth century, believed that all life had a vital force that could change nonliving matter to living matter. Their texts displayed frogs being produced from mud, and mice evolving from filthy shirts and wheat. An early attempt to disprove this belief was in the form of a series of experiments conducted in 1668 by an Italian physician named Francesco Redi.



Our task is to duplicate his experiment using the materials provided by your instructor. You are not expected to duplicate his exact experiment but to conduct and set-up a similar, scientifically acceptable experiment.

PROCEDURE (Directions to students)

1. State or define the problem to be investigated in this laboratory experiment.
2. Read the sections in your textbook that discuss spontaneous generation.
3. Based on your readings and classroom discussion, state a hypothesis for your experiment.
4. Select a sample of materials on display and design an experiment that proves your hypothesis.
5. Record the steps to be followed in your experiment.

Notes to Teacher:

- Prior to this laboratory exercise, you should review the scientific method and assign a number of readings related to spontaneous generation for homework.
- Place the listed materials on the demonstration desk. Determine quantities based on 10 to 12 groups of students working 2 to 3 in a group.

TIME: 30 minutes

STUDENT WORKSHEET

Name: _____

Biology Class: _____ Laboratory Experiment No.: _____

I. Statement of problem: _____

_____

_____

II. Hypothesis: _____

_____

III. Experimental design: _____

_____

_____

_____

_____

_____

Be sure to list all materials used and the exact procedure to be followed. A detailed diagram is advisable and should be included.

LABORATORY SKILL 2: Given a laboratory problem, select suitable lab materials, safety equipment, and appropriate observation methods.

INVESTIGATION: To demonstrate the effect of environmental conditions on the germination of seeds.

PROBLEM (Background)

Flora and fauna come in apparently endless varieties. Some types of plants and animals, however, are found only in certain geographic areas and are rarely seen in other areas. For instance, an array of cactus plants would be commonplace in the desert of the West, but cannot be expected in New York City's Central Park.

In this investigation you will design an experiment that illustrates the effects of various environmental conditions on the germination of selected seeds. You will be responsible for selecting the materials to be used, exercising appropriate safety precautions, and providing accurate observations.

PERFORMANCE OBJECTIVES Students will be able to:

- design an experiment that demonstrates an understanding of the scientific method.
- illustrate the effects of environmental factors on seed germination and plant growth.
- collect and analyze data.

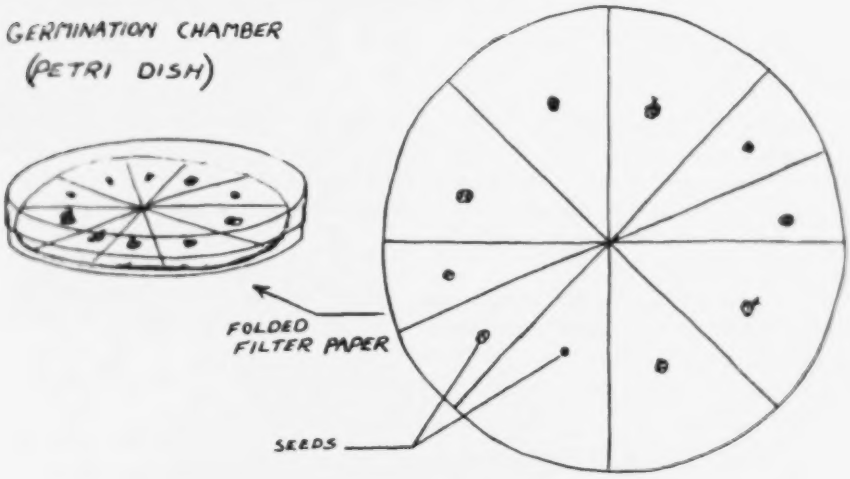
MATERIALS

petri dishes (To avoid placing one type of seed in each petri dish teachers are advised to divide the dishes by folding filter paper as per illustration. This technique provides side-to-side comparison while saving equipment and storage.)
variety of seeds: radish, lettuce, tomato; substitute as desired (Select

seeds that are relatively small so that many fit into the ten compartments. Corn and bean seeds are too large)
filter paper (size determined by circumference of petri dish)
storage space in refrigerator
incubators
adhesive tape for sealing lids of petri dishes
forceps or tweezers for placing seeds in containers
crayon marking pencils
thermometers for accurate daily measurements
suggested tables or charts (Students may substitute their own.)

PROCEDURE (Directions to Students)

1. Select a number of different seeds on display and place them in a germination chamber.



2. Place the germination chamber in a variety of environmental conditions; you may restrict it to those available in your laboratory, or you may wish to investigate other conditions elsewhere.

3. Design a chart to illustrate or summarize the data observed in this experiment.

Species	Environment: Control	Cold Dark	Cold Light	Warm Dark	Warm Light

Total Number of Seeds Germinated ____

4. Graph the results.
5. Interpret the results.
6. What precautions should have been taken to prevent fungus from developing in the germination control?

Notes to Teacher:

The object of this experiment is make students aware of the effects of environmental conditions in controlling or limiting types of plants that grow in particular areas and not in others. Preceding this lesson, students should have a knowledge of the requirements for seed germination and the various abiotic conditions that affect it. (Suggestion: teams of three to four students)

TIMING

1. Students can easily set this experiment up in a single period.

2. Most seeds will germinate in 7 to 14 days.

3. Students should be encouraged to make daily observations and keep a log.

4. A good deal of this experiment may be performed by the student at home by placing seeds in a refrigerator or closet.

FOLLOW-UP

Oral report and/or mini-research paper: problem, hypothesis, materials, experimental design, observations (charts and graphs), conclusions.

LABORATORY SKILL 3: Distinguish between constants and variables in an experiment.

INVESTIGATION: To verify the optimum temperature needed for the growth of a bacteria culture.

PERFORMANCE OBJECTIVE Students will be able to:

. design an experiment that clearly distinguishes between a control and a variable.

MATERIALS

petri dishes with sterilized agar
incubator (Students suggest various temperatures, (such as, control at 25°C, at 10°C (refrigerator), and at 40°C)
marking pencils
non-pathogenic bacterium (Try yogurt cultures; make sure packaging says "active cultures".)

PROBLEM (Background)

Knowing the optimum temperature for the growth of bacteria is important to many industries. For instance, the expiration date of dairy products is in part determined by the rate at which bacteria grow at a certain temperature. You will be investigating this phenomenon by using a single bacterium and exposing it to different temperatures. Your experiment must contain an appropriate control and variables. As with all experiments you must record and interpret your observations.

PROCEDURE (Directions to Students)

1. Review procedures for preparing, inoculating, and culturing bacteria.
2. Record the optimum temperature and growth conditions for bacterium - this information is provided by supplier or in a standard college microbiology textbook.
3. Set up three conditions--one control and two variables related to temperature.

10°C
REFRIGERATOR

25°C
CONTROL

40°C
INCUBATOR

PETRI DISHES

4. Observe at 24, 48, and 72 hours.
5. Record the results on chart (suggested format is shown, but students may design their own).
6. Graph the results, interpret the data.

SUGGESTED CHART

Time (hours)	Number and Size of Colonies			
	Control	Variables		
	25° C	40° C	20° C	10° C
24				
48				
72				

Notes to Teacher:

1. Before this exercise, students should have guidance in bacteriological procedures and safety precautions.

2. Select nonpathologic bacteria such as active cultures of yogurt, where inoculation may be grown rapidly in advance of the experiment at minimal expense. (Biological suppliers supply a wide variety of cultures.)

3. Prepare nutrient agar in advance so students need only inoculate the cultures.

ALTERNATIVE

Compare results with different species of bacteria.

TIME REQUIRED

. One period to inoculate and design experiment.
. One period the following week to interpret the results.

Additional experiments: controls and variables.

. Examine different cultures of bacteria at a constant temperature.
. Examine effects of different types of culture media on the same species of bacterium.
. Place two species of bacterium in the same petri dish; check for competitiveness.

LABORATORY SKILL 4: Identify parts of a light microscope and their functions and focus in low and high power.

INVESTIGATION: To prepare a microscope slide and observe the specimen under low and high power.

PERFORMANCE OBJECTIVES Students will be able to:

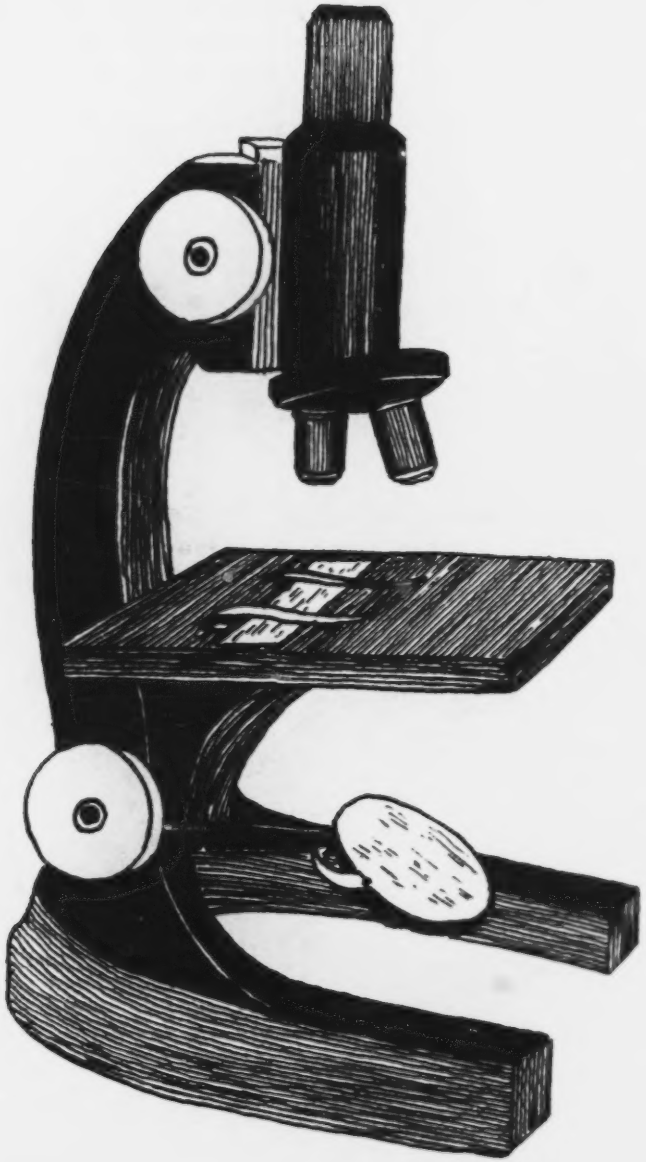
. state the name and function of the major parts of a microscope.
. focus clearly on a specimen on a slide, using both high and low power.

MATERIALS

compound light microscope
diagrams of a microscope for labeling
glass slides
cover slips
lens paper
eye droppers
teasing or dissecting needle
tweezers or forceps

PROBLEM (Background)

The major tool in the arsenal of the biologist is the microscope. The world that exists invisible to the naked eye was unknown to scientists for thousands of years. Only recently has nature been exposed on its molecular level. In this exercise students will learn the parts of a microscope, make a slide, and draw what they observe under low and high power.



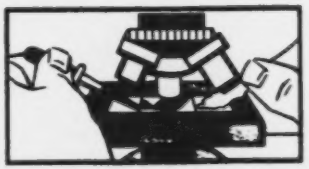
335

235

PROCEDURE (Directions to students)

1. Label the parts of the microscope in the diagram and state a function for each.

2. Follow your teacher's instruction in preparing a wet-mount slide of a strand of wool. Illustration #2



3. Summarize instructions for placing the slide on a microscope and focusing at low power. Draw what you see. Illustration #3

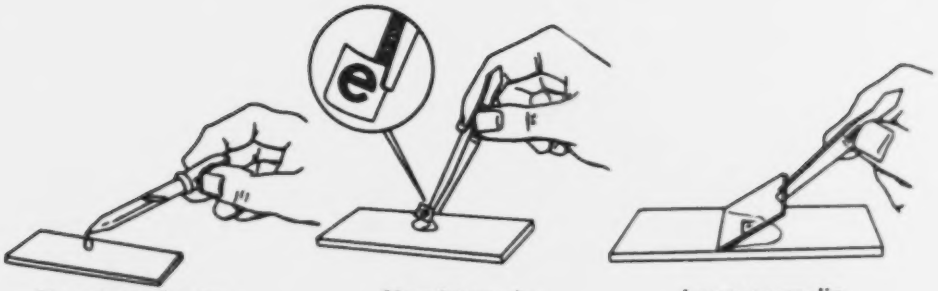
4. Follow the same procedure for high power. Illustration #4

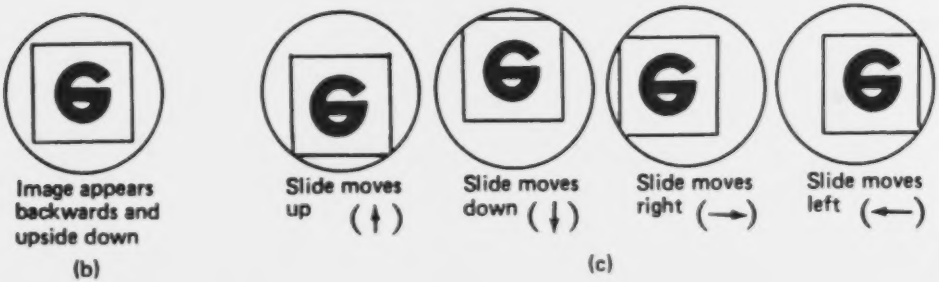
MICROSCOPIC FIELD OF VIEW

LOW POWER VIEW 10X

HIGH POWER VIEW 40X

5. "Letter e lab" is significant in that all of the skills listed in this exercise are tested. In addition, direction, size, and perception are provided.
   a. prepare a wet-mount slide of lower case letter e
   b. observe a draw under lower power and high power
   c. note apparent direction of movement, as viewed through the lens, as you move the slide to the right, left towards you and away from you.





For students interested in "extra credit", suggest that they research the physics of optics and light in order to provide an explanation of the phenomeno observed in the "letter e lab".

Notes to Teacher:

Time for this experiment should be allocated as follows:

Period 1: Identify, label, and state function and care of microscope.
Period 2: Focus low and high power with prepared slides. Draw and label.
focus only on high power
use caution and up
Period 3: Give instruction on making a wet mount using a variety of specimens. Place under microscope. Focus and draw.

LABORATORY SKILL 5: Determine the size of microscopic specimens in micrometers (microns).

INVESTIGATION: To use the light compound microscope to measure the size of microorganisms.

PERFORMANCE OBJECTIVE Students will be able to:

. determine and record the size of microscopic specimens in microns.

MATERIALS

light microscopes
plastic or transparent millimeter rulers
prepared slides (onion root or protozoa)
glass slide
cover slips
lens paper
dissection or teasing needles
tweezers or forceps
pond water and/or pollen and/or any specimens small enough to measure under the microscope

PROBLEM (Background)

By this time students have learned the names of the parts of the microscope and have conducted a number of experiments that require them to observe specimens at high and low power. Now they must be able to use these skills to measure the size of specimens viewed under the microscope.

PROCEDURE (Directions to students)

1. Review conversion factors between micrometers and millimeters.

2. Place a transparent plastic millimeter ruler on the microscope stage. Draw the view under low power.

3. Use the following calculation to determine the diameter of the high power field:

   a. Estimate diameter at low power (e.g., 1.5 mm).

   b. Substitute numbers in the following formula:

      low power magnification x low power diameter = high power magnification

4. Look at the objectives of your microscope and record the numbers indicated. For example:

$$\frac{10}{43} \times 1.5 = 0.35\text{mm}$$

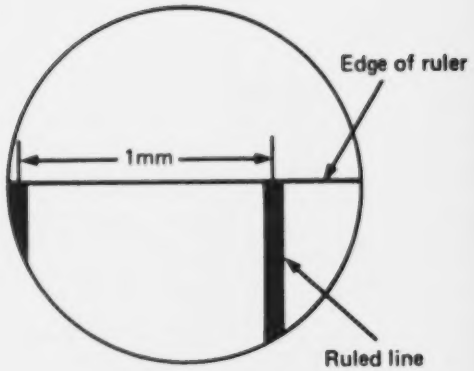
Recall the conversion function:

$$1 \text{ micrometer} = \frac{1 \text{ mm}}{1000}$$

Therefore, 1.5 mm = 1500 micrometers under low power.

The field under high power is 350 microns. Notice that the greater the magnification, the smaller the field viewed. That is the reason large objects cannot be fully viewed under high power.

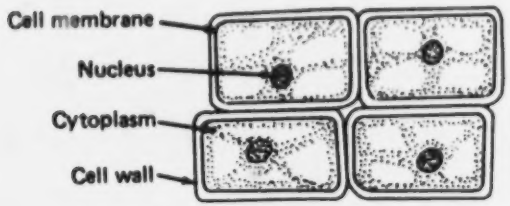
5. Now select a number of objects or specimens or make your own wet-mount slide. Draw what you see and estimate the size of each.



The field of view is 1.4 mm or 1400 μm.

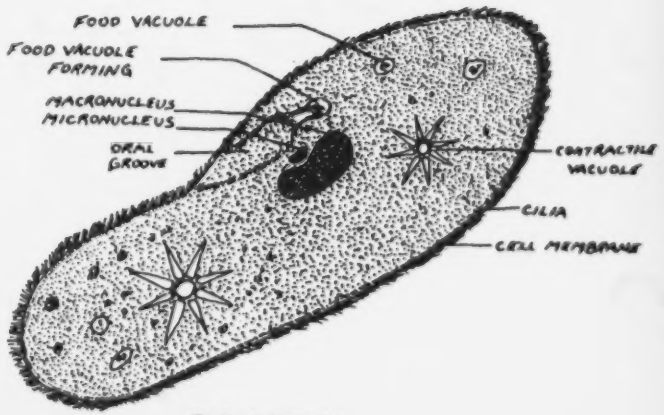
Example:

Removing a thin section of onion tissue.



Onion skin cells.

Estimated size:
1/2 mm or
500 micrometers



PARAMECIUM

6. Repeat the procedure under high power and for a minimum of three different specimens.

Notes to Teacher:

- Review structure and care of the microscope and construction of a wet-mount slide.
- One period may be required for demonstrating the use of a transparent ruler and use of equations. Once the preliminaries are completed, the excercise should not take more than 30 minutes.

LABORATORY SKILL 6: Prepare wet mounts of plant and animal cells and apply staining techniques using iodine or methylene blue.

INVESTIGATION: To test different stains of specimens and compare them in terms of clarity in identifying organelles.

PERFORMANCE OBJECTIVES Students will be able to:

- prepare wet mounts of plant and animal cells.
- apply Lugol's solution and methylene blue to specimens.
- compare, draw, and label organelles visible without stain and with each of the two stains.

PROBLEM (Background)

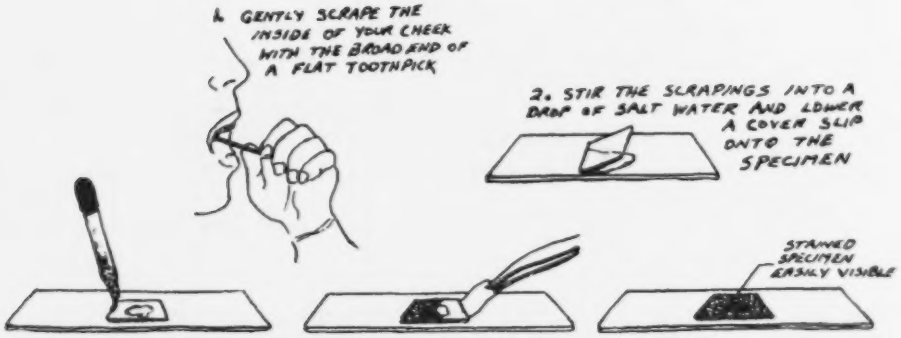
Many specimens are so extremely thin that light may penetrate them completely. The thinness of the specimen often allows so much light to pass through that details are washed away and cannot be seen. Staining is a technique that is used selectively to color portions of a specimen, thus holding back some of the light while permitting light to pass through other parts. Some stains differentially color specific organelles (or parts of cells).

In this exercise students will view different animal and plant specimens, unstained and stained. They will draw the specimens and compare their drawings, stating under which conditions the viewing is most ideal.

PROCEDURE (Directions to students)

1. Select samples of onion tissue or lettuce (or whatever samples are provided in your class). The samples should be colorless, e.g., do not use red cabbage or red onion.

2. Review techniques for making a cheek cell scraping.


1. GENTLY SCRAPE THE INSIDE OF YOUR CHEEK WITH THE BROAD END OF A FLAT TOOTHPICK
2. STIR THE SCRAPINGS INTO A DROP OF SALT WATER AND LOWER A COVER SLIP ONTO THE SPECIMEN
STAINED SPECIMEN EASILY VISIBLE
3. TO OBSERVE GREATER DETAILS ADD A DROP OF METHYLENE BLUE OR LUGOL'S SOLUTION AND DRAW THE STAIN UNDER THE COVER SLIP BY TOUCHING A PIECE OF LENS PAPER TO OPPOSITE END.

SLIDE PREPARATION OF HUMAN CHEEK CELLS

3. Prepare three wet mounts of the plant and animal cells. Stain two with Lugol's solution, one with methylene blue. View, draw, and compare.

Notes to Teacher:

1. Before this exercise, students should receive instruction in the following things:

   -use of the microscope
   -preparing a wet mount
   -preparing a cheek-cell mount

2. A demonstration should be provided for developing proper staining techniques.

3. Commercially prepared slides effectively demonstrate ideal staining techniques.

4. Estimated time: If background is developed as outlined above, the exercise should take no more than 30 minutes. Be creative. Bring a variety of specimens to class and allow your students to select from them.

LABORATORY SKILL 7: Identify cell parts under the compound microscope, such as the nucleus, cytoplasm, chloroplast, and cell wall.

INVESTIGATION: To view a variety of plant cells under a microscope and label the major organelles.

PERFORMANCE OBJECTIVES Students will be able to:

. prepare a wet mount of an elodea plant leaf.
. draw and label the nucleus, cytoplasm, chloroplast, and cell wall.

MATERIALS

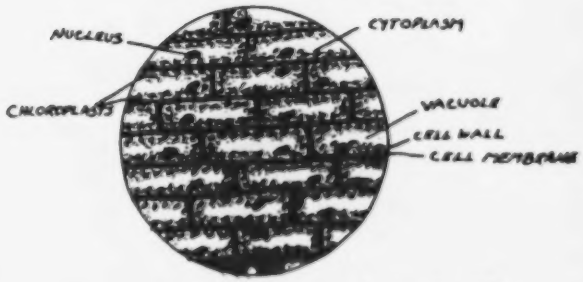
compound light microscope
glass slides
cover slips
lens paper
tweezers
dissecting needles
elodea leaves
onion slices

PROBLEM (Background)

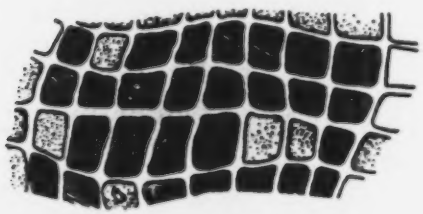
For more than 300 years scientists have observed the basic unit of life--the cell. However, details of cell structure such as lysosomes and ribosomes are a relatively new discovery. Much of what we have studied about the cell may be seen only with an electron microscope. The compound light microscope is still a very useful instrument, even though we may not view the smallest organelles. With a compound microscope, we will be able to view the nucleus, cytoplasm, chloroplast and cell wall. (The cell membrane is much too small to be seen, although we usually mark it as the boundary outside the cell.)

PROCEDURE (Directions to students)

1. Make a wet mount of a single elodea plant leaf. (Staining is not needed.)
2. Focus under low and high powers.
3. Draw and label structures listed in the problem.
4. Do the same procedure with an onion cell. Compare with the elodea.
5. Finally, cut a thin piece of cork. View as above and compare.



ELODEA CELLS (HIGH POWER)



The microscopic structure of a piece of cork.

Notes to Teacher:

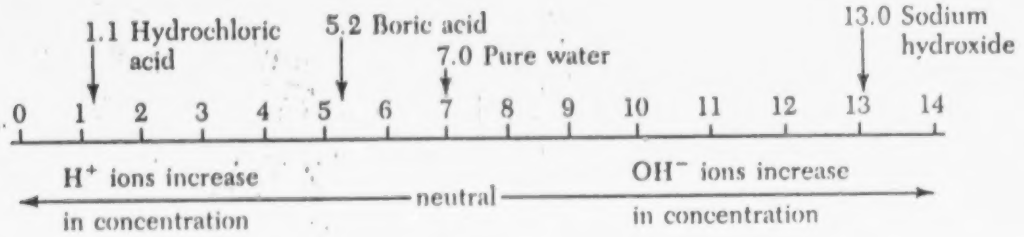
All of the skills required for this experience should have been taught previously. Thus, a brief overview of the problem should suffice. Elodea plants are obtainable from most pet stores. They are relatively inexpensive. A single sprig contains enough leaves for an entire class. The plant may be kept fresh by placing it in a gallon container (fish tank) and providing adequate light. Even if the plant is not rooted upright, but simply allowed to float, it will remain visible for many weeks.

Estimated time: 1 period

LABORATORY SKILL 8: Use and interpret pH paper, Benedict's (Fehling's) solution, iodine (Lugol's solution), and brom-thymol blue.

Notes to Teacher:S

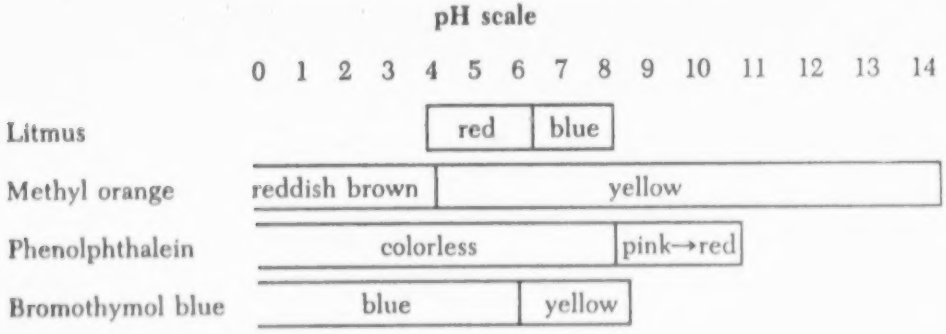
. Unlike the preceding lab skills, this one is really a summary of many lab experiences. In this instance we shall provide a number of possible experiences or activities that can demonstrate each of the skills listed above.


1.1 Hydrochloric acid
5.2 Boric acid
7.0 Pure water
13.0 Sodium hydroxide
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
H+ ions increase in concentration
neutral
OH− ions increase in concentration

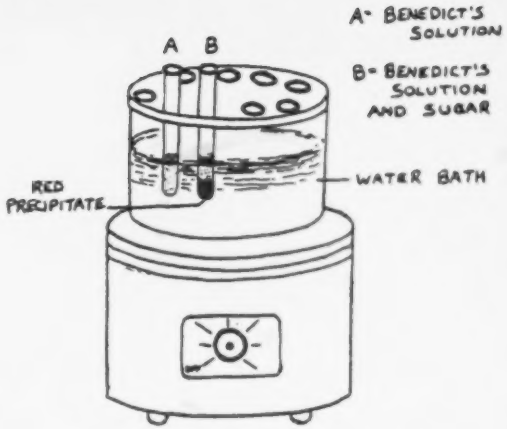
The pH scale.

1. **pH Paper:** Display a number of solutions of varied pH. Distribute hydrion paper (1 to 14) guide range. Students should test each unknown solution for pH and identify as acid, base, or neutral. *Common indicator illustration

Some Common Indicators and their pH Ranges



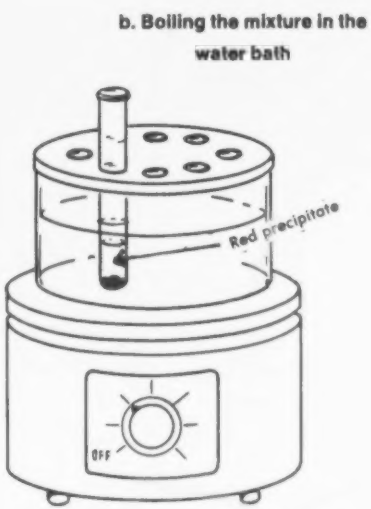
2. Benedict's (Fehling's) solution: Demonstrate tests for sugar. Substance prepared in test tube with Benedict's solution will turn solution brick red when heated if sugar is present. Students can test unknowns for the presence of sugar.



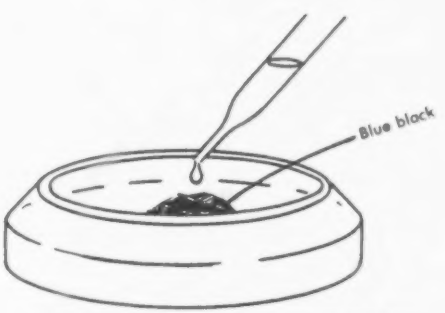
TESTING FOR SIMPLE SUGAR

3. Iodine (Lugol's solution): Conduct the test for starch. Lugol's solution turns blue-black when starch is present. Combine items 2 and 3. Skills allow the student to test unknown solutions for sugar and starch.

4. Brom-thymol blue: Indicator turns yellow in acid solution. It may be used to test solutions and when combined with hydrion paper the exercise can serve as a control.



TESTING FOR SIMPLE SUGAR



ADDING LUGOL'S IODINE TO ~~THE SEED PASTE~~ a squirt of Starch

LABORATORY SKILL 9: Use and read measurement instruments such as metric rulers, thermometers, and graduate cylinders.

INVESTIGATION: To measure the dimensions of a plant cell.

PERFORMANCE OBJECTIVES Students will be able to:

- calculate, in metric dimensions, the size of the low and high power fields of a microscope.
- add these measurements to determine the length and width of a plant cell.
- compare the depth of a cell to its length and width.

PROBLEM (Background)

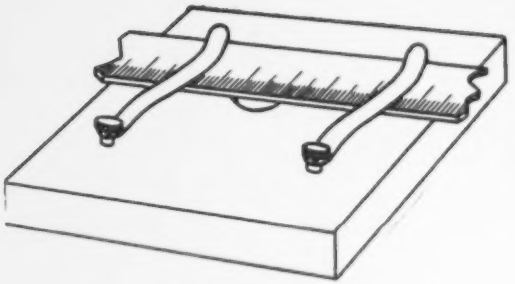
Students should measure and compare the size of cells found in nature. An appreciation of the internal structure of a cell allows students to be aware of the many interactions of organelles in cells, as well as organs in organ systems. Modern medicine requires a knowledge of the primitive finite nature of organisms. Students in science must be made aware, through actual measurement, of the size and amounts of physical structures and reagents used in studying living things.

PROCEDURE (Directions to students)

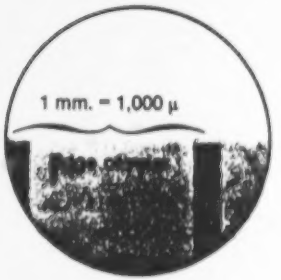
1. In order to measure the size of cells, a clear plastic ruler can be placed under a microscope. By determining the number of millimeters and microns in the field of view, the length, width, and depth of elodea cells can be measured.

2. Adjust the microscope for proper focus and lighting. Place the clear metric ruler under low power and high power. On low power, focus on the lines marking the millimeters; switch to high power.

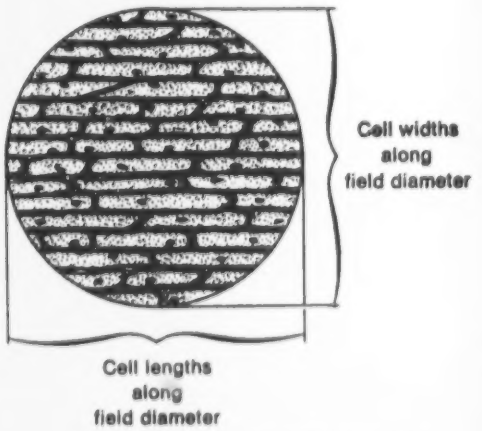
3. Once you have determined the size of the field (low power and high power), place the elodea leaf under the microscope. Focus on one cell and line it up along a diameter of the field. Use fine adjustment and estimate the relative proportion of depth to length and width.



PLACING THE RULER ON THE MICROSCOPE STAGE



ESTIMATING THE WIDTH OF THE FIELD



ESTIMATING THE SIZE OF CELLS

SAMPLE WORKSHEET

Estimated Dimensions (low power)

Field diameter _____ (microns)

Cell length _____ (microns)

Cell depth _____ (microns)

Cell width _____ (microns)

Draw cell under low and high power

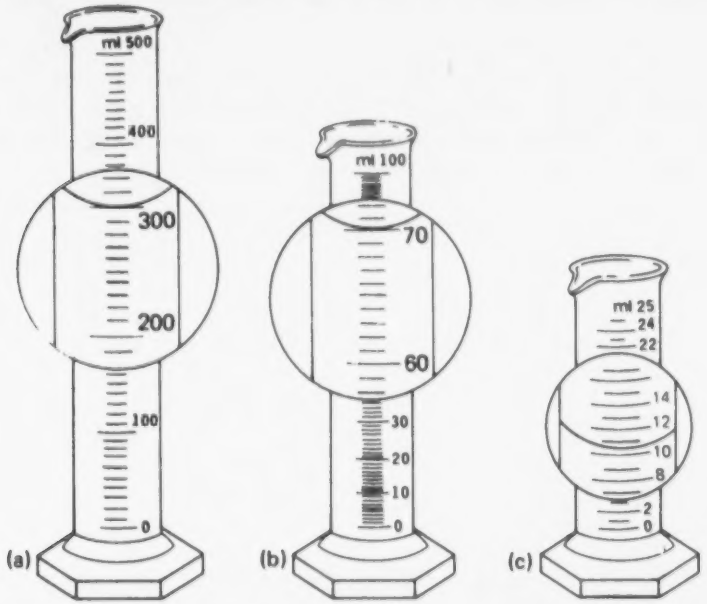
Notes to Teacher:

- Students often have difficulty using the mirror, the diaphragm, and the adjustment knobs. It is surprising that high school students have never used or learned how to use their own microscope. The first lessons on the use of the microscope should allow students to use the instrument, know the name and function of each part, and examine an object in both fields of magnification. As a means of sharpening their skills, use a crystal (salt) as an object since it is impossible to lose under magnification.

ADDITIONAL EXERCISES

In other lessons students can utilize graduated cylinders to learn the correct way to measure the meniscus and record the correct columnar readings. The use of a thermometer must also be reviewed. These tasks can be introduced in a lesson on techniques used in cell study in Unit I (Unity and Diversity among Living Things).

The three graduated cylinders below all contain a volume of fluid. Read the volume as indicated in each and record your answer next to the appropriate letter.



(a) _____ (b) _____ (c) _____.

LABORATORY SKILL 10: Dissect plant and animal specimens for the purpose of exposing major structures for suitable examination. Seeds, flowers, earthworms, and grasshoppers may be used.

INVESTIGATION: To dissect a flower.

PERFORMANCE OBJECTIVES Students will be able to:

. identify major structures of plants and animals by dissection experiments. Organisms are carefully selected for the most appropriate study.

PROBLEM (Background)

With proper care and preparation in planning, the teacher can help students learn from actual experience, using individual specimens of plants and animals. Special care is indicated in the choice of animals. Organisms like frogs (Rana pipien) can be replaced with other vertebrates as an ecological conservation measure.

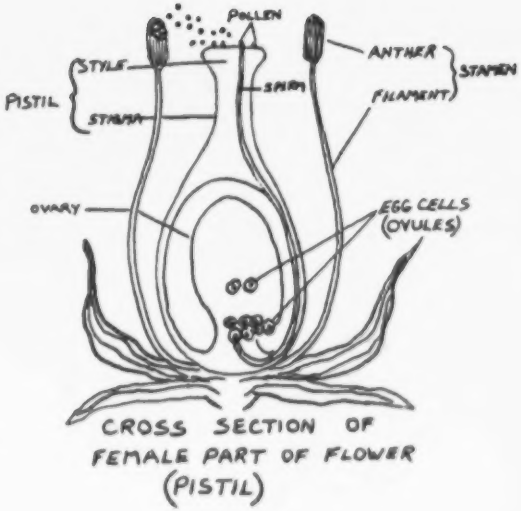
Use of the angiosperm for study of plant reproduction is recommended. The gladiolus has several florets on each stalk and can be obtained at a relatively low cost. The flower has green bracts as well as sepals and petals of the same color. These considerations must be addressed in the study of flower parts in reproduction. The structures can be mounted for identification and the relationships to function can be listed.

PROCEDURE (Directions to students)

1. Carefully examine the undissected flower. Observe the attachments of the flower to the stalk and identify the bract by comparing it to the picture.

2. Observe the sepals and petals and study their shape and color. Remove the sepals and use tape to attach them to the diagram provided. Remove the stamens and attach to the diagram.

3. Carefully cut the ovary open using a scalpel. Observe the ovules. Place the dissected part in the diagram and attach, using the tape. Place a pollen grain and ovule under the microscope at low power.



CROSS SECTION OF FEMALE PART OF FLOWER (PISTIL)

SAMPLE WORKSHEET

Record the number of

sepals _____

petals _____

ovules (estimate)_____

Draw a diagram of the structure of a pollen grain and ovule. How does the difference in structure of these gametes compare to their function?

Dangerous Vapors

Notes to Teacher:

[CAUTION SYMBOL] [DANGEROUS VAPORS]

. Safety first! Using a scalpel to dissect out parts of the plant can be hazardous. Students should be directed to learn the proper use of the scalpel. The anatomy of the flower should be studied before the laboratory exercise. Animals preserved in formaldehyde or other preservative solutions should be washed carefully before using. Rubber gloves should be worn by students. Ventilation should be monitored by the teacher. Avoid exessive inhalation.

. Petals and sepals in the gladiolus are the same color. The bract is green. The teacher should stress the difference. (Availability and price determine the flower to be used.) These few exceptions in structure can be pointed out to students as examples of the diversity among living things. (Point out abnormalities in other organisms.)

. The pasting of parts onto a notebook page is a valuable exercise. Many students like to keep their labeled plant sheet for future study. It is a valuable piece of realia that they can keep.

LABORATORY SKILL 11: Demonstrate safety skills involved in heating materials in test tubes or beakers, use of chemicals, and handling of dissection instruments.

INVESTIGATION: To test for sugar.

PERFORMANCE OBJECTIVE Students will be able to:

. learn and understand the safety precautions for every experiment. The reasons for each procedure, especially those related to safety, should be elicited from the students.

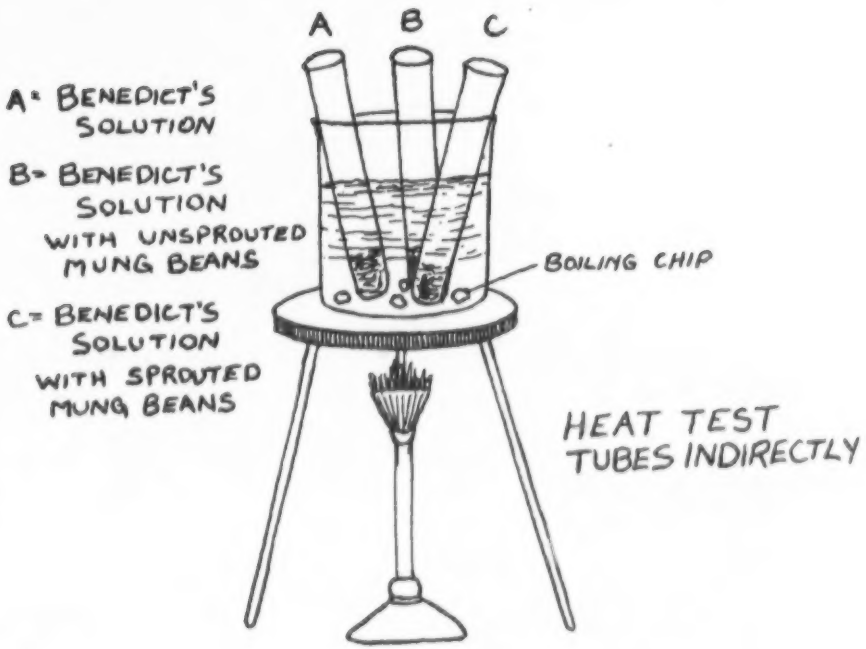
PROBLEM (Background)

Careful scientific investigation is important to the student and the scientist. Safety precautions must be taught to the entry-level science student and must be carried out in all future studies. Careful use of materials, as well as maintenance of a safe laboratory station, are essential.

Using mung beans (sprouted and unsprouted) you can detect sugar in seeds and develop an understanding of the reasons for its presence in a particular type of seed.

PROCEDURE (Directions to students)

1. Place Benedict's solution in each of three test tubes.
2. Place unsprouted mung beans in the second test tube and sprouted mung beans in the third test tube.
3. Place the test tubes in a beaker placed in a tripod. Use a boiling chip to prevent bumping.
4. Light a Bunsen burner and heat. Observe the changes in color.



Notes to Teacher:

. Safety first! When using open test tubes, heating directly over a flame can be dangerous. The purpose of the beaker can be determined by comparing with direct heating. The test tube should be held with a holder, and the open end should be pointed away from the other students and away from one's own body. The use of an alcohol lamp deposits carbon at the base of the test tube and covers up any possible color changes.

SAMPLE WORKSHEET

List of Reactions and Color Changes

Contents

A	1	2	3	
B	1	2	3	4
C	1	2	3	4

Color Changes

A

B

C

1. Ask the students the following:
   . How does the boiling chip provide safe heating?

   . How does indirect heating provide safety?

   . What does the asbestos wire mesh provide?

2. How do the mung beans in test tubes B and C differ? What effect does sprouting have on the new plant? How is sugar involved in the germinating process?

LABORATORY SKILL 12: Collect, organize and graph data.

INVESTIGATION: To use a graph to represent enzyme activity.

PERFORMANCE OBJECTIVES Students will be able to:

- use experimental data collected from observations.
- organize data into a systematic presentation of results. (This presentation can be a graph or chart.)

PROBLEM (Background)

Students should be able to set up an experiment where data are to be collected, organized, and presented in a form that is easy to interpret (i.e., graphical representations, charts).

They will observe catalase activity in different cells. The cut pieces of tissue are tested in test tubes of hydrogen peroxide. Tissue samples are treated with vinegar, ammonia, boiling water, frozen water, and other factors affecting enzyme activity.

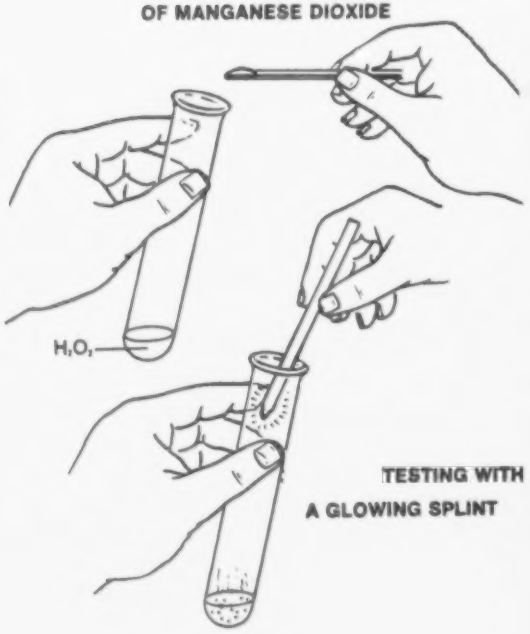
PROCEDURE (Directions to students)

- Place samples of liver (whole or chopped), celery, carrot, and tomato into a series of test tubes containing H_2O_2. Observe activity in relation to bubbles produced (low, medium, or high). Use glowing splint test for oxygen in each. Record results according to temperature and pH for each type of cell. Present data using a bar graph or chart.

Notes to Teacher:

- Students often read homework assignments and skip the pictorial and graphical representations. The use of graphs and charts should be an integral part of all lessons including lab lessons. The use of bar graphs and circle graphs can be found in articles. (The New York Times-- Tuesday science section --often displays graphs. These can be used in lessons to allow students to appreciate the use of these representations of data.) The lab lesson can allow students to graph their own data and thus experience scientific representation of data. Errors in graphical representation from scientific research should be interpreted in class. Classic misrepresentations of data by scientists can be discussed in relation to specific studies to familiarize students with all types of studies (e.g., saccharin, coffee research).

  Students often have a jaundiced view of all research. Analysis of data represented on graph and charts (percentages) can allow them to be selective in their decision making skills.



GRINDING LIVER WITH
A MORTAR AND PESTLE

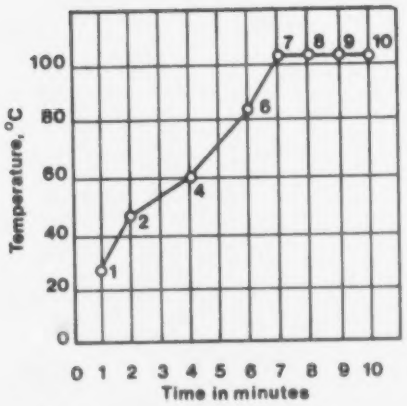


Figure 8–2. Heating water to boiling temperature.

Table: Heating Water to Boiling	
Time (in Min.)	**Temperature (in degrees Celsius)**
1	27 °C
2	48 °C
3	—
4	60 °C
5	—
6	80 °C
7	100 °C
8	100 °C
9	100 °C
10	100 °C

Figure 8–3. Data table shows the same information as the graph.

Examine the line graph in Figure 8–4. Notice that there are two lines in the graph: the dashed line represents Liquid A; the solid line represents Liquid B. The two lines compare the changes in temperature of the two liquids when heated over a period of time. Look at Figure 8–5. Here the same data presented in Figure 8–4 is presented on a **bar graph.** In a bar graph, two or more sets of numerical data can be compared.

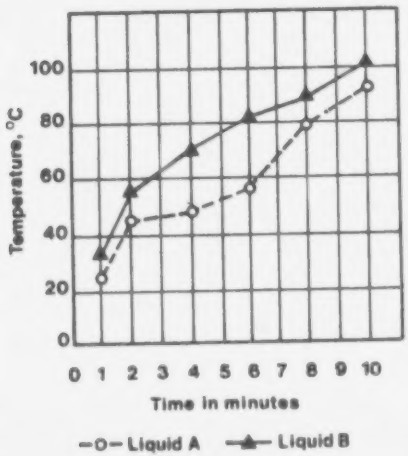


Figure 8–4. Line graph.

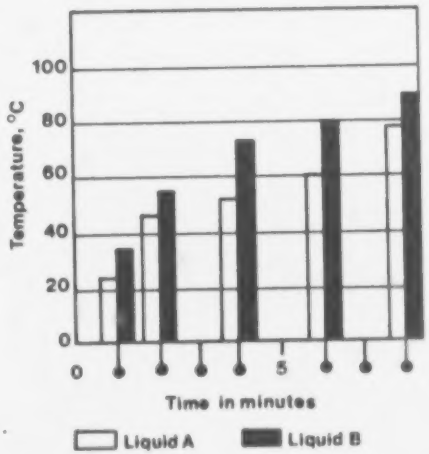


Figure 8–5. Bar graph.

SAMPLE STUDENT WORKSHEET

ACTIVITY (O_2 production)

Plant Activity

Tissue	0° C (freezing)	100° C (boiling)	pH acid (vinegar)	pH basic (ammonia)
am't of bubbles	low, med., high	low, med., high	low, med., high	low, med., high
1. liver (whole)				
2. liver (chopped)				
3. carrot				
4. celery				
5. tomato				

How does each factor affect enzyme activity?

Draw a graph showing enzyme activity in relation to: (a) temperature, (b) pH.

How does chopping affect the enzyme activity?

LABORATORY SKILL 13: Make inferences and predictions based upon data collected and observed.

INVESTIGATION: To determine the effect of antibiotics on bacterial growth.

PERFORMANCE OBJECTIVES Students will be able to:

. use data to predict outcomes from new testing situations. Inferences from one set of data can be made and appled to new situations.

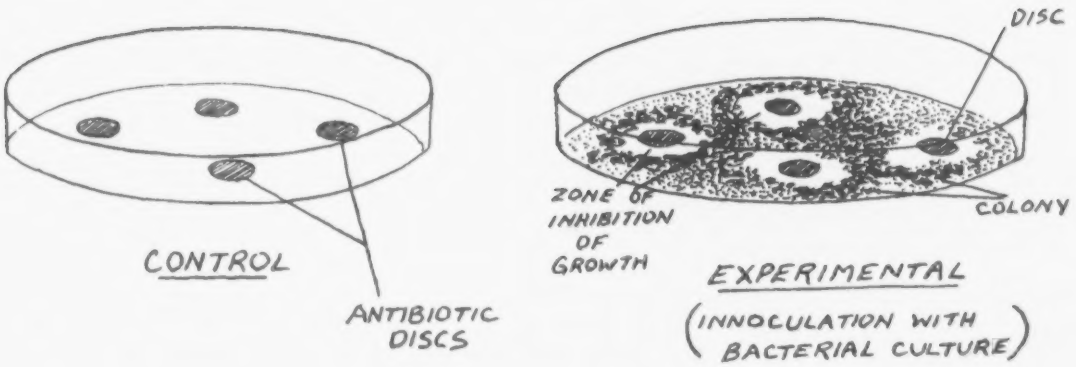
PROBLEM (Background)

Students should be able to use data to arrive at inferences for future projects. Information should be applied to new situations where predictions can be made. Petri dishes using mouthwash of different types can be tested. Students can use this information to predict results of the experiment when determination of mouthwash was tested by the Food and Drug Administration. Comparisons can be made with student-run and government-run research projects. (Results of FDA research on common mouthwashes can be found in Bio Abstracts.)

PROCEDURE (Directions to students)

1. Soak filter paper in mouthwash. Punch out paper disks using a hole punch. The discs should be dry when placed in a petri dish in which saliva has been spread over the surface of agar plates. A control dish is used with identical discs.

2. Seal the petri dish with tape (clear) to prevent opening of a possible pathogen culture. Incubate and ask students to infer the relative affects of mouthwash as measured by the size of the zones of inhibition.



Notes to Teacher:

- Students should be taught to respect the use of sterile procedures. The historical example of the research of Robert Kock and his postulates on the determination of the cause of a disease can be reviewed.

  The whole area of the study of disease is now a part of the Regents syllabus. We should make every effort to discuss the practical considerations of procedures to maintain a relatively germ-free environment. At the very least, we must make students aware of the rationale behind commonly accepted procedures of daily life. Topics such as refrigeration and the use of food preservatives can be discussed.

SAMPLE WORKSHEET

Draw and label the growth patterns of each dish.

Experimental	Control

1. How does each mouthwash affect bacterial growth?_____

_____

2. What does an incubator provide for bacteria?_____

_____

3. How would you improve the design of this experiment?_____

_____

LABORATORY SKILL 14: Formulate generalizations of conclusion of the investigation.

INVESTIGATION: To interpret data on the analysis of nirogenous bases in thymus, spleen, and sperm cells.

PERFORMANCE OBJECTIVES Students will be able to:

. induce generalized conclusions from experimentally derived data.

PROBLEM (Background)

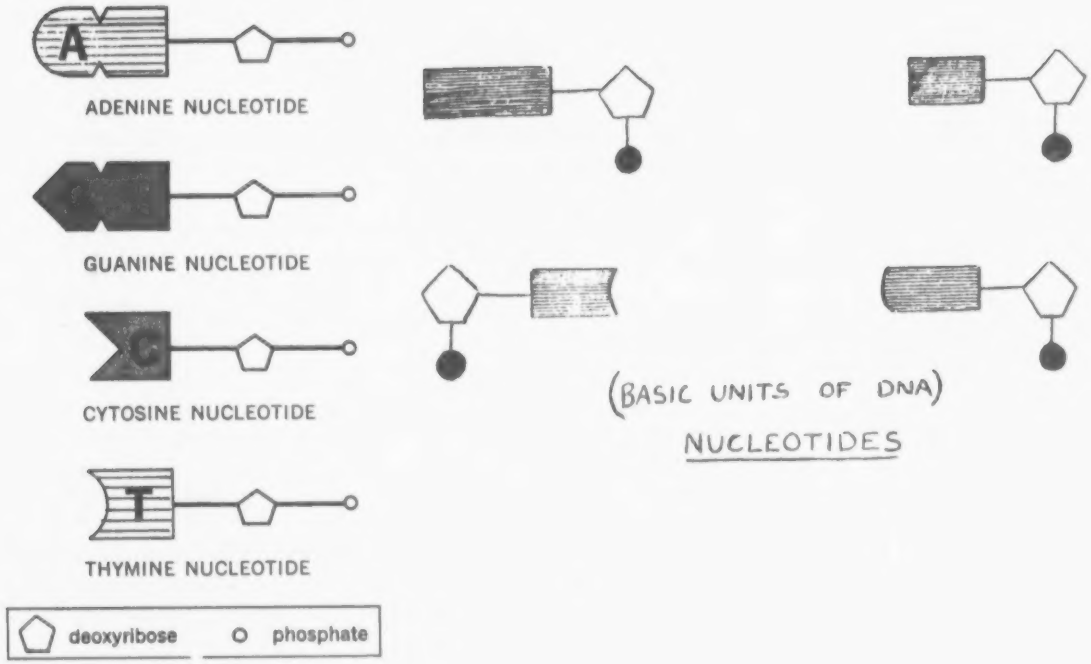
Students should be able to reach conclusions from the testing of hypotheses. Generalizations can be made from specific data if the students have had experience with setting up experimental hypotheses and have been taught the inductive approaches followed by others.

By using prepared cutouts of nucleotides (two sets of four), students will be asked to build a mode of DNA (one small section). Using Erwin Chargaff's data, students will show the relationship of pairing of purine and pyrimidine bases from experimental results.

PROCEDURE (Directions to students)

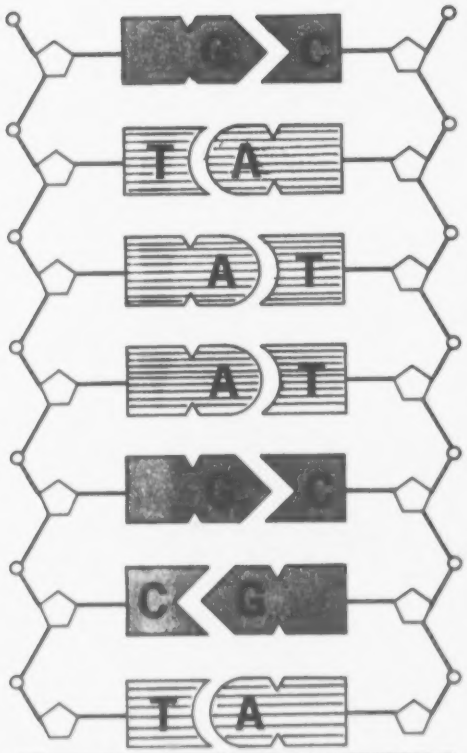
1. By the process of trial and error, put these two sets of bases together to make a single molecule of DNA.

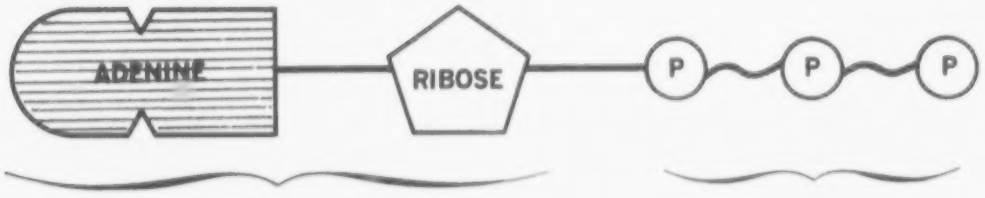
2. Use the chart of Ervin Chargaff's data to assist you in reaching a generalization about the chemical and physical structure of DNA.



(BASIC UNITS OF DNA)

NUCLEOTIDES





A
ADENOSINE

TP
TRIPHOSPHATE

370

371

Notes to Teacher:

1. The only preparation required for this exercise is to arrange in advance for copies of the data presented in the exercise. Encourage students to graph the data in a variety of ways and to interpret the information directly from the data.

2. An ideal follow-up exercise may include students suggesting a hypothesis to explain the data and to support their hypothesis by offering a proposal for further research. This exercise may be started in class but should be completed at home.

3. Format for submitting the completed assignment can range from a simple graphical representation and accompanying narrative to a formal term paper inclusive of a structured experimental procedure for future research.

SAMPLE WORKSHEET

Percentage of Composition

Tissue and Organism	Nitrogenous Bases			
	adenine (purine)	guanine (purine)	thymine (pyrimidine)	cytosine (pyrimidine)
Thymus cells				
human	30.9	19.9	29.4	19.8
sheep	29.3	21.4	28.3	21.0
pig	30.9	19.9	29.4	19.8
Spleen cells				
human	29.2	21.0	29.4	20.4
sheep	28.0	22.3	28.6	21.1
pig	29.6	20.4	29.2	20.8
Sperm cells				
human	30.7	19.3	31.2	18.8
sheep	28.8	22.0	27.2	21.0
Yeast cells	31.3	18.7	32.9	17.1

1. What generalizations can be made from this chart of experimentally derived data?

2. How does your experimental evidence compare with these results?

LABORATORY SKILL 15: Assess the limitations and assumptions of the experiments.

INVESTIGATION: To apply Mendel's laws.

PERFORMANCE OBJECTIVES Students will be able to:

. assess the limits of their experiment.
. make assumptions about the course of their investigation.

PROBLEM (Background)

All scientists set parameters in order to limit the scope of their investigations. Assumptions are made to guide the formulation of hypotheses. The testing of a limited number of hypotheses allows for selective study of data.

How can we determine the results of a hybrid cross? Use two coins (a penny can represent a male heterozygote and a nickel can represent a female heterozygote--why?). Each side represents a possible gamete with heads of each coin a dominant trait and tails a recessive trait.

PROCEDURE (Directions to students)

1. Each of you will toss each coin simultaneously 100 times and record your results. The class results will be tabulated. Observed results will be compared with expected results.

   The use of a chi square test will provide a statistical basis for the project.

$$\text{chi } (x^2) \text{ square} = \frac{(\text{obs} - \text{exp})^2}{\text{exp}}$$

2. What limitations are found with this experiment?

3. What assumptions are made with the use of two coins?

4. What assumption does the chi square technique utilize?

SAMPLE WORKSHEET

Individual Report of Tosses

OBSERVATIONS

	RECORD OF 100 TOSSES		
	TT (two heads)	Tt (head and tail)	tt (two tails)
Totals			

Notes to Teacher:

- The determination of the results of a hybrid cross can be tabulated individually and as a class.
- The use of the chi square technique is a valuable tool. Students can appreciate the limits of individual samples by comparing their results with the class.
- A discussion of raw scores and percentile ranks of Scholastic Aptitude Test (SAT) scores could be a direct application of the assessment of students in a limited and nationwide sample.

LABORATORY SKILL 16: Determine the accuracy and reliability of the experimental data and observations.

INVESTIGATION: To test vitamin C content in a variety of fruit juices.

PERFORMANCE OBJECTIVES Students will be able to:

- verify data from each other's experiments.
- recognize that the purpose of repeating experiments is to rule out results obtained by faulty procedures.
- realize that generalizations made from too few trial experiments may be faulty.

PROBLEM (Background)

The true test of experimental research is the verification of results. Many treatments for cancer have been attempted, but few have been verified by scientists. Repeating experiments determines their accuracy. Independent verifications are necessary before research is considered valid. Students can verify research by repeating the process of particular experiments. Sometimes classic experiments can be repeated for verification and for learning experiences.

The following experiment will show how we can determine the relative vitamin C content in different juices.

Students can compare the amount of vitamin C in different samples. First, a standardization must be performed with ascorbic acid to decide what special concentration of ascorbic acid will decolorize a definite amount of indolphenol. Students can then test with other samples and compare accuracy with other test results.

PROCEDURE (Directions to students)

Indolphenol dye changes from blue to colorless in the presence of ascorbic acid (vitamin C).

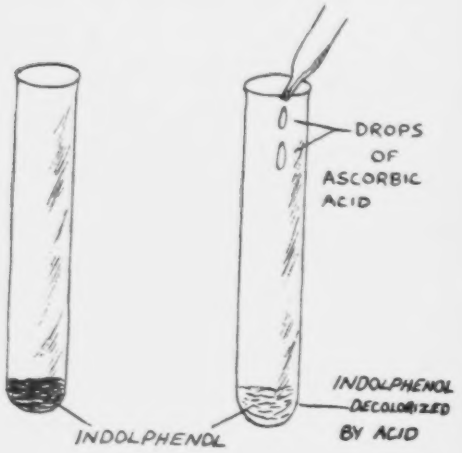
A. Into each of two test tubes place 15 drops of indolphenol. To one test tube, add 0.1% ascorbic acid solution drop by drop. Count the number of drops necessary to decolorize the solution. Repeat this procedure using 0.5% solution of ascorbic acid.

B. Into each of three test tubes place 15 drops of indolphenol. Using canned, frozen, and fresh orange juice (or other citrus) test for amount of ascorbic acid.

C. Compare the results obtained using the 0.1% ascorbic acid solution with the results obtained for each juice. Estimate the relative quantities of ascorbic acid in each juice by using a scale of 0 to 3. (none = 0, little = 1, moderate = 2, a lot = 3)

Record data on a worksheet provided.

STANDARDIZATION TECHNIQUE



SAMPLE WORKSHEET

Name and type of juice orange pineapple grapefruit

No. of drops indolphenol _____

Ascorbic acid content _____

Relative quantity of
ascorbic acid _____

(Scale 0 - 3)

1. What do your results suggest?

2. How accurate were your results compared to others in your class?

3. What factors might affect the accuracy of the test results.

4. How would you change this experiment to (a) make it more accurate (b) make it more practical for consumers?

Notes to Teacher:

. Students should be able to assess their experiment and apply this knowledge to other assessments made by the Food and Drug Administrations rulings in (a) Laetrile (b)saccharin. They should develop an appreciation of tests to determine product safety for public use. Show students that reading labels is important to them as consumers.

Career Information (by unit)

380

CAREER INFORMATION

UNIT I

Career	Job Description	Education Requirement
Food inspector	Inspects meat, poultry, and their by-products to insure they are safe for public consumption.	B.A. or B.S., experience, pass a State exam based on specialized knowledge.
Bacteriologist	Tests samples of urine, spinal fluid, throat cultures, materials from wounds, and blood.	B.S. degree specializing in medical technology
Gem cutter	Cuts, shapes, and polishes precious and synthetic gems. May cut and polish diamonds for industrial purposes and be designated "Industrial Diamond Polisher."	High School diploma, on-the-job training, experience
Genetics counselor	Analyzes determiminants responsible for specific inherited traits, such as color differences and size, and devises methods for altering them or producing new ones.	B.S. degree
Animal caretaker	Assists veterinarian in care, feeding and treatment of animals	High School Diploma, may require added courses.

Doctor of veterinary medicine	Diagnoses and treats diseases and disorders of animals. Determines nature of disease or injury and treats animals surgically or medically.	Doctor of Veterinary Medicine from accredited college, pass written and oral State exams
Laboratory technician	Performs tests and laboratory procedures that require a high level of skill but not the in-depth knowledge of highly trained technologists.	Two years of post-secondary school
Patholologist	Diagnoses, through laboratory procedures, from body tissue, fluids, secretions, and other specimens, presence and stage of disease. Performs autopsies to determine cause of death.	Advanced degrees in medicine
Dental assistant	Provides diagnostic aid for dental procedures, including exposing radiographs, taking and recording medical and dental histories, recording vital signs, making preliminary impressions; sterilizes instruments and equipment, prepares tray setups for dental procedures.	Graduation from an accredited two-year college

NOTE: The majority of the above careers require a heavy concentration in science courses, as well as varying degrees of post high school study. All require extensive use of the microscope.

CAREER INFORMATION

UNIT II

Career	Job Description	Education Requirement
Biochemist	Conducts research to determine action of foods, drugs, serums, hormones, and other substances on tissues and vital processes of living organisms.	Advanced science degree preferably Ph.D.
Forester	Manages timberland that is scattered over a wide area. Duties include budgeting, planning, mapmaking, and overseeing the planting, cleaning, harvesting, and selling of trees.	B.A. degree in forestry. Advanced degree preferred
Tree surgeon	Prunes and treats ornamental and shade trees and shrubs in yards and parks to improve their appearance, health, and value.	High School and on-the-job training
Entomologist	Studies various aspects of insects--their origin, behavior, diseases, and life processes.	High School Diploma
Floral designer	Arranges flowers, cares for plants	M.A. degree for beginning job. Ph.D. preferred

Conservationist	Soil conservationists advise on forestry problems and conduct educational programs on care of forests.	B.S. in agronomy.
Food technologist	Applies scientific and engineering principles in research, development, production technology, quality control, packaging, processing, and utilization of foods.	M.S.
Animal breeder	Develops systems of breeding desirable characteristics, such as improvement in strength, maturity rate, disease resistance and meat quality, into economically important animals.	M.S.
Clinical chemist	Examines chemistry of blood corpuscles.	B.S., Ph.D. preferred
Pharmaceutical salesperson	Sells drugs and medical supplies to pharmacies and hospitals.	B.S.

CAREER INFORMATION

UNIT III

Career	Job Description	Education Requirement
Dialysis technician	Sets up and operates artificial kidney machine to provide dialysis treatment for patients with kidney dieseases.	Two-year associate degree
Practical nurse	Provides bedside care needed by hospital patients. Takes temperature and blood pressure, changes dressings, and bathes patients.	License required from State-approved program
Dental assistant	Responsible for preparation of dental materials and sterilization of instruments.	High school diploma plus on the job training or one-two yr. college program
Dietician	Plans and manages food service programs and advises on good eating habits.	B.S. and internship
Repiratory therapist	Uses special equipment such as respirators and positive-pressure breathing machines to treat patients who need temporary or emergency respiratory assistance.	A.A. or B.S. degree
Emergency medical technician	Administer first aid to sick and injured people. They work in two person teams. Many EMTs work for police and fire departments.	High school diploma, 100 hour basic training program, and

		a valid driver's license.
Urologist	Diagnoses and treats diseases and disorders of the genitourinary organs and tract.	M.D.
Audiolologist	Specializes in diagnostic evaluation of hearing; prevention, rehabilitative services for auditory problems, and research related to hearing disorders.	B.S.
Optician	Prepare and fit eyeglasses and contact lenses. To prepare contact lenses the optician measures the corneas of the customer's eyes. Special optical tools are utilized.	Two-year special program
Optometrist	Examines people's eyes, prescribes lenses, corrective eye exercises and other treatment not requiring drugs or treatment.	Doctor of Optometry (O.D.) from an accredited postgraduate Optometric school and State Board examinatio
Biomedical engineer	Conducts research into biological aspects of humans or other animals to develop new theories and facts or to test, prove, or modify known theories of life systems, and to design life-support apparatus, utilizing principles of engineering and bio-behavioral sciences.	B.S. in engineering and four year medical school program
Crime lab technician	Helps solve crimes, gathers photographs and preserves evidence that is used to reconstruct events or behavior.	High school diploma plu a two year technical school or junior college.

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CAREER INFORMATION

UNIT IV

Career	Job Description	Education Requirement
Nurse-midwife	Provides medical care and treatment to obstetrical patients under supervision of physician, delivers babies, and instructs patients in pre- and post-natal care.	Nursing program and license by State board
Nurse's aide	Works in hospital assisting nurses in daily routine care.	High School diploma
Neonatolologist	A physician who is responsible for the care of newborn infants.	M.D.
Social worker	Helps individuals, families, groups, and communities understand and deal with their problems.	M.S.W. (Masters in Social Work)
Pediatrician	Places and carries out medical care programs for children from birth through adolescence.	M.D.
Geneticist	Studies inheritance and variation of characteristics in forms of life.	M.D.
Agronomist	Conducts experiments or investigations in field-crop problems and develops new methods of growing crops to secure more efficient production, higher yield, and improved quality.	Ph.D.

Seed analyst	Tests seed for germination, purity, and weed content.	B.S.
Horticulturalist	Conducts experiments and investigations on problems of breeding, production, storage, processing, and transit of fruits, nuts, berries, vegetables, flowers, bushes, and trees.	Ph.D.

CAREER INFORMATION

UNIT V

Career	Job Description	Education Requirement
Cytotechnologist	Stains, mounts, and studies cells of human body to determine pathological condition. Reports information to pathologist.	Two-year associate degree from accredited college
Entomologist	Studies insects and their relation to plant and animal life. Identifies and classifies species of insects and allied forms, such as mites and spiders.	Advanced degree
Sonographer	Uses high frequency sound waves to "photograph" organs of the human body. Reports findings to a physician who uses information to diagnose or treat specific organ.	Two-year degree from accredited college
Nuclear medical technologist	Performs chemical, microscopic, hematological, parasitic, and bacteriologic tests to provide data for use in treatment and diagnosis of disease. May take electrocardiograms.	Two-year degree from accredited college
Physical therapist	Helps people with muscle, nerve, joint, and bone disease and injuries to regain some of their strength and ability to move.	B.S. from accredited college program, license required

CAREER INFORMATION

UNIT VI

Career	Job Description	Education Requirement
Biology specimen technician	Prepares and imbeds in plastic, biological specimens of plant and animal life for use as instructional aids.	B.S. degree, major in biology
Archeologist	Reconstructs record of extinct cultures, especially preliterate cultures. Studies, classifies, and interprets artifacts, architectural features, etc., in order to determine age and cultural identity.	Ph.D. usually required
Taxidermist	Prepares, stuffs, and mounts skins of birds or animals in lifelike form.	B.S. degree with major in anatomy
Research assistant	Conducts research on historic monuments buildings, and scenes to reconstruct exhibits to scale in dioramas.	B.S.
Geologist	Studies composition, structure, and history of the earth's crust. Applies knowledge of chemistry, physics, biology, and mathematics to explain the processes affecting development of the earth.	Ph.D. preferred
Demographer	Plans data collection and analyzes and interprets numerical data from experiments, studies, surveys, and other souces. A demographer specializes in specific aspects of statistics regarding human population.	B.S.

CAREER INFORMATION

UNIT VII

Career	Job Description	Education Requirement
Game warden	Patrol special natural areas. Keep records of animal behavior, plan controlled hunts, warn people of protected species, etc.	High School diploma plus some college training
Herpetologist's assistant	Studies and treats reptiles and amphibians	High School diploma and on the job training.
Fish Farmer	Raises and breeds varieties of fish for stocking of ponds, fish pollution control, etc.	High School diploma and on the job training.
Meteorologist	Develops and evalutes calibration systemsthat measure characteristics of objects, substances, or phenomena such as length, mass, time, temperature, electric current, luminuous intensity, and derived units of physical or chemical measure.	B.S. and specialized study
Environmental Scientist	Conducts research studies to develop theories or methods of abating or controlling sources of environmental pollutants.	Ph.D. preferred
Parasitologist	Studies characteristics, habits, and life cycles of animal parasites such as protozoans, tapeworms, roundworms, flukes, and other parasitic organisms, to determine their effects on humans.	Ph.D.

Toxicologist	Studies the effect of poisonous substances on living things.	Ph.D.
Range manager	Conducts research in range problems to provide sustained production of forage, livestock and wildlife.	Ph.D.
Soil conservationist	Plans and develops coordinted practices for soil erosion control, moisture conservation, and sound land use.	B.S. and experience
Farmer	Grows and harvests more than one kind of crop, such as fruit, grain, vegetable, and specialty crop, applying market conditions and agricultural knowledge applicable to kinds of crops raised.	High School, B.S. preferred
Agricultural engineer	Applies engineering technology and knowledge of biological sciences to agricultural problems concerned with power and machinery, electrification, structures, soil and water conservation, and processing of agricultural products.	B.S.
Aquatic biologist	Studies plants and animals living in water, and environmental condition affecting them.	B.S. or Ph.D.
Beekeeper	Cleans, inspects hives; harvests honey; improves stock.	High school diploma plus some special courses.

Career Information Resources

393

American Institute of Biological Sciences
1401 Wilson Boulevard
Washington VA 22209

Civil Service Commission
1900 E Street NW
Washington, DC 20415

Association of Medical Illustrators
6650 Northwest Highway
Chicago, IL 60631

Biomedical Engineering Society
P.O. Box 2399
Culver City, CA 90230

American Society of Cytology
Jefferson University
130 South 9th Street
Suite 1006
Philadelphia, PA 19107

Society of Nuclear Medicine
475 Park Avenue South
New York, NY 10016

American Medical Association
Department of Pathology
535 North Dearborn Street
Chicago, IL 60612

American Veterinary Medical Association
930 North Meacham Road
South Chaumburg, IL 60196

American Genetic Association
1028 Connecticut Avenue NW
Washington, DC 20036

Institute of Agricultural Technology
Michigan State University
East Lansing, MI 48823

American Statistical Association
806 15th Street NW
Washington, DC 20005

American Society of Biological Chemists
9659 Rockville Pike
Bethesda, MD 20014

American Association of Conservators and Restorers
1250 East Ridgewood Avenue
Ridgewood, NJ 07450

American Geologic Institute
5205 Leesburg Pike
Falls Church, VA 22041

American Anthropological Association
1703 Hew Hampshire Avenue, NW
Washington, DC 20009

American Society of Microbiology
1919 I Street NW
Washington, DC 20006

Myrology Society of America
University of Michigan
Ann Arbor, MI 48104

American Pharmaceutical Association
2215 Constitution Avenue NW
Washington, DC 20037

Water Pollution Control Federation
2626 Pennsylvania Avenue NW
Washington, DC 20037

Society of American Florists
and Ornamental Horticulturists
901 North Washington Street
Alexandria, VA 22314

American Society of Landscape Architecture, Inc.
1750 Old Meadow Road
McLean, VA 22101

Institute of Agricultural Technology
Michigan State University
East Lansing, MI 48823

Biological Photographic Association
P.O. Box 1057
Rochester, MN 55901

American Society of Oceanography
1730 M Street NW
Suite 412
Washington, DC 20036

American Society of Parasitologists
South Western Medical School
Dallas, TX 75235

American Fishery Society
5410 Grosvenor Lane
Bethesda, MD. 20014

American Society of Zoological
Parks and Aquariums
Oglebay Park
Wheeling, WV 26003

American Association of Medical Assistants
1 East Wacker Drive
Suite 1510
Chicago, IL 60601

American Medical Writers Association
5272 River Road
Suite 290
Bethesda, MD 20014

American Nurses Association
2420 Pershing Road
Kansas City, MO 64108

U.S. Department of Agriculture
Forest Service
Washington, DC 20250

Society for Range Management
2760 West Fifth Avenue
Denver, CO 80204

Soil Society of America
677 South Sequel Road
Madison, WI 53711

SAMPLE LESSON PLAN:

CAREERS

CAREER LESSON: Job Title
Laboratory Technician

AIM:

How can you learn to work with a medical examiner?

PERFORMANCE OBJECTIVES Students will be able to:

- describe the role of a laboratory technician
- list the criteria for selection for this career.
- investigate educational opportunities available for preparation in this field.

MOTIVATION

Show slides of tests for different blood types. Discuss a possible role for these tests in crime detection. Relate the work of the medical examiner's laboratory to the detection of criminal activity.

CONCEPTS

- Analysis of crime requires scientific inquiry.
- Requirements for a career include preparation for two years in a crime laboratory technology college program.
- Personality requirements include curiosity, responsibility, and possession of good judgment.

CONCEPT QUESTIONS

- How does crime detection require the skills of a scientist?
- How does a laboratory technician specializing in forensic (law-related) medicine use the skills of a doctor? Lawyer? Reporter?
- What steps must a candidate for this career take in order to meet the educational requirements for this position?
- What are the opportunities for advanced study (and advancement) after entry level requirements are met?

EVALUATION FORM

BIOLOGY REGENTS RESOURCE MANUAL

The Biology Regents Resource Manual is a guide for teachers in assisting them to provide demonstrations and activities in their science lessons that are unique and appropriate for the various topics in the Biology Regents course of study.
Further printings of this publication shall include additional demonstrations and activities suggested by our staff. Also, recommendations for deleting certain suggested activities will likewise be considered.

Please answer the questions below as completely as you can, assured that your reactions will be much appreciated and given most repectful consideration in compiling the revised edition. Please send your completed evaluations to:

Dr. Anthony A. Galitsis, Director of Science
Board of Education of the City of New York
Science Unit - Room 409
131 Livingston Street
Brooklyn, New York 11201

NAME: _____ SCHOOL: _____

SCHOOL ADDRESS: _____

NUMBER OF STUDENTS REGISTERED IN REGENTS BIOLOGY: _____

ABILITY LEVEL OF STUDENTS: _____

1. Are the demonstrations clearly explained? ___ YES ___ NO

   Explain: _____

2. Are the demonstrations appropriate for the subject matter? ___ YES ___ NO

   Explain: _____

3. Is the format of this resource manual useful? ___ YES ___ NO

   Explain: _____

4. Is the manual well organized? ___ YES ___ NO

Explain: _____

5. Would you make any changes in the types of activities presented in this manual? ___ YES ___ NO

Explain: _____

6. Did the suggested activities enable you and your students to achieve the performance objectives? ___ YES ___ NO

Explain: _____

7. Did any of the suggested laboratory activities cause problems? ___ YES ___ NO

Explain: _____

8. Is there any difficulty in implementing the demonstrations or activities? ___ YES ___ NO

Explain: _____

9. What additions, deletions, or changes would you recommend?

_____

10. What changes would you make to improve the quality of this document?

_____

11. Do you have any additional comments?

_____